IMPLEMENTATION OF LIFELINK™ CONNECTIONS AT BROOKE ARMY MEDICAL CENTER (BAMC)

Final Report

March 19, 2001

Submitted By:

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6220 Culebra Rd.
San Antonio, Texas 78238

In Response To:

Basic Contract Number: V674P-2995
Order Number: 674-W00138

DISTRIBUTION STATEMENT A
Approved for Public Release
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20010518 038

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LIST OF ACRONYMS

ATMS	Advanced Traffic Management System
BAMC	Brooke Army Medical Center
CAT5	Category Five (Copper Network Cable)
CODEC	Video Coder-Decoder or Compresser- Decompresser
dB	Decibel
ED	Emergency Department
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
FC	Type of fiber optic connector
FO	Fiber Optic
GHz	Giga-Hertz
IP	Internet Protocol
ISR	Institute of Surgical Research
LAN	Local Area Network
Mbps	Mega-bits Per Second
MM	Multi Mode (optical fiber)
NMT	Not More Than
OTDR	Optical Time Domain Reflectometer
PS	Power Supply
RJ-45	Type of modular electrical connector used in networks
Rx	Receiver
SAFD	San Antonio Fire Department
SC	Type of fiber optic connector
SM	Single Mode (optical fiber)
SNMP	Simple Network Management Protocol
SwRI	Southwest Research Institute
TOC	Traffic Operations Center
TWT	Time Warner Telecom Company
Tx	Transmitter
TxDOT	Texas Department of Transportation
UPS	Uninterruptible Power Supply
VHS	Very High Speed (video tape recording system)

INTRODUCTION

This is the Final Report submitted under the above contract number entitled "Implementation of LifeLink™ Connections at Brooke Army Medical Center (BAMC)". This report describes the work that was performed during the course of the project, describes the technical configuration of the installation at BAMC, and reports on testing and demonstration activities using the equipment at BAMC.

OBJECTIVE

The objective of this project was to provide equipment and services as required to establish a "Hospital Terminal" node at BAMC that is connected and functioning within the LifeLink™ system in San Antonio, Texas. The availability of the LifeLink™ Hospital Terminal and the related communications that connect BAMC into the LifeLink™ network will facilitate related research and data collection activities and position BAMC to participate in the use of the LifeLink™ system during pre-hospital medical oversight in actual medical emergencies.

DESCRIPTION OF THE LIFELINK™ SYSTEM

The LifeLink™ system is a distributed mobile LAN designed to link ambulances on or near San Antonio's freeway system with trauma care providers in the city. Several key functions or features found in the LifeLink™ system are listed below:

1. The LifeLink™ system is a high capacity hybrid terrestrial/wireless mobile communications network that provides the required connectivity for telemedicine applications between moving vehicles and hospitals.
2. The system reflects an engineered solution adapting telemedicine to the emergency medical environment. Automation of call placement and management, largely transparent to the users, is featured. Automatic management of communications, computer systems, power systems, and other technologies are built into the LifeLink™ system.

3. Networking of video and other required data to provide important options in medical control of emergency situations is provided. The intuitive and easy-to-use capability to switch medical control among appropriate departments or physicians online and/or to share data from the field for consultation purposes, again online and immediate, reflect a revolutionary step in telemedicine applications. This capability was also judged significantly important to the use of telemedicine in the emergency environment.

The link utilizes the facilities and roadside fiber-optic network of Texas Department of Transportation's (TxDOT's) Transguide™ Advanced Traffic Management System (ATMS), as shown in Figure 1. A video teleconference is initiated at the discretion of the ambulance crew. Once established, the link can be handed off from hospital node to hospital node, but only one hospital node can interactively communicate with an ambulance at a time. Consulting hospital nodes may view the video and listen to the conversation but are not able to participate in the conference except through normal telephone contacts between hospital nodes. The LifeLink™ system supports multiple nodes within a hospital and nodes distributed among multiple hospitals. Each ambulance carries a computer that is configured for a LAN-based video teleconferencing application. The view at each hospital node of the teleconference is a full screen view of the video sent by the ambulance node with a small image in the corner of the screen containing the local image that is being sent. A status bar is placed at the bottom of the screen indicating the current ambulance unit number and other support information.

The digital video communications system at the heart of the LifeLink™ system provides a very important feature in a wireless environment. Occasional transient losses of communications are inevitable and are due to noise, interference, multi-path interference, loss of line of sight, and combinations of these phenomena. The LifeLink™ system handles these issues by controlling video performance to take maximum advantage of the available digital throughput at any time. Reduced throughput is reflected by reduced frame rates in the displayed video, and most communications breaks go unnoticed.

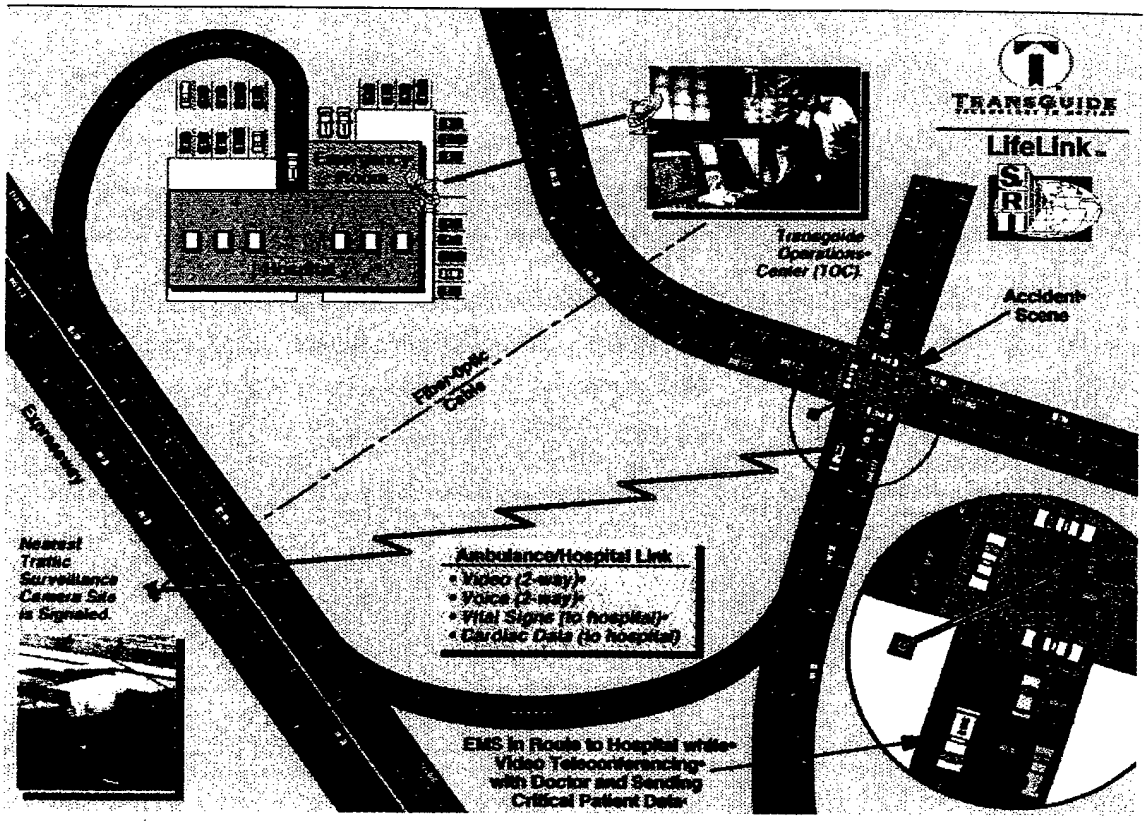

Figure 1. Graphic Illustration of LifeLink™ Terrestrial/Wireless Communications

When communication is lost completely, such as when operating out of range, etc., then the last frame of video is displayed as a still picture, providing the best available image until communication is restored.

The system uses a wireless link between an ambulance and a nearby Transguide™ camera location. The Transguide™ cameras are typically located at intervals of one to one-and-a-half miles apart along the city's freeway system. An unlicensed 2.4 GHz spread spectrum radio is located in each ambulance and on each camera pole. The line-of-sight radio link operates to connect the ambulance to the nearest suitable camera location and to seek a new connection when the existing connection begins to fade, thus providing continuous interconnect as the ambulance moves along the freeway system.

The half-duplex digital radio using Ethernet-like protocols is connected to a full duplex converter within each associated Transguide™ fiber hub. A long-haul fiber transceiver then interconnects the duplex converter to each of the Tx and Rx fibers, which terminate within the Transguide™ building.

These fibers are currently used in the Transguide™ system, and wave-division multiplexer techniques are used to operate the LifeLink™ system on the existing fiber network but at a different light wavelength. This technique basically uses some of the unused bandwidth available in the Transguide™ fiber backbone.

Within the Transguide™ building, a switched hub is located and fitted with long-haul fiber transceivers. A network management computer is located near the switched hub. The switched hub operates to interconnect any one of the hospital nodes with an ambulance in the field as directed by the ambulance crew. Only one ambulance can use any camera location at a time; however, multiple hospital nodes may interconnect with multiple ambulances simultaneously as long as the ambulances are geographically separated or otherwise positioned so that separate camera locations can be used. Typically, a LifeLink™ ambulance can "see" two or three Transguide™ camera locations at any time. The switched hub within the Transguide™ facility connects to a communications system capable of supporting the required connection(s) between the Transguide™ facility and the respective hospital(s). In some cases, this is a leased T1 telephone line. Ultimately, all communications links between Transguide™ and the member hospitals will be over Transguide™ fiber to the nearest (to the hospital) fiber hub and dedicated fiber between the fiber hub and hospital will complete the link, as is the case for the BAMC link established during this project.

METHODS

There were seven major areas of work required to provide the desired functional LifeLink™ terminal at BAMC:

1. Interconnect BAMC and Transguide™ (the LifeLink™ network) with a suitable communications means.
2. Implement suitable communications within BAMC to facilitate location and connection of the terminal within BAMC to the network.
3. Implement a functional terminal at BAMC to operate within the system.
4. Adjust the LifeLink™ network to accommodate the new terminal at BAMC.
5. Test the BAMC terminal and the system with the BAMC terminal in place and operating.
6. Explore potential opportunities to use the vital data telemetry feature of the LifeLink™ system.
7. Provide LifeLink™ training and demonstrations at BAMC. Conduct coordination discussions for use of the system with the BAMC terminal added.

Work within the subject project to accomplish these major work items is described in this report.

THE INTERCONNECTION OF BAMC AND TRANSGUIDE™

The Transguide™ system is continuing to grow in geographical scope to cover more miles of freeway in the San Antonio area with communications and traffic management assets. Recently, this growth in highway coverage extended the system along Interstate 35 near the BAMC physical plant. Discussions with Time Warner Telecom (TWT) company, which provides telecommunications services to Ft. Sam Houston (where BAMC is located) yielded an opportunity to obtain an optical fiber segment capable of linking the BAMC building with the Transguide™ fiber network along the highway. The availability of this fiber segment was the key to establishing a full fidelity operational LifeLink™ terminal within BAMC. SwRI worked to obtain agreements by TxDOT and TWT for each to provide

labor, materials, and services as required to place new conduit and fiber between their respective existing networks. SwRI worked with each "partner" to specify and implement the necessary interfaces between the systems and to accomplish necessary fiber allocation and splicing within the respective systems to interconnect the new fiber and provide optical continuity between BAMC and Transguide™, thus providing the desired interconnections. The new fiber and conduit placed underground to facilitate the subject system interconnection bridged a distance of approximately one-fourth of a mile. The work in this task resulted in two dedicated single mode optical fibers providing optical continuity between the TWT fiber patch panel in the communications switch room at BAMC and the fiber patch panel for the LifeLink™ system within the Transguide™ facility.

Measurements of pertinent parameters for the resulting optical link between BAMC and Transguide™ were accomplished using an Optical Time Domain Reflectometer (OTDR). The results of those measurements and other pertinent information are reported in Table 1.

Table 1. Dedicated LifeLink™ Fiber Identification, Distance, and Loss Data

BAMC Fiber Terminus	Transguide™ Fiber Terminus	Total Fiber Distance	Optical Loss 1310nM	Optical Loss 1550nM
TWT fiber panel Panel A, position 5	I-35 fiber panel Panel #2, position 143	15.8 miles	9.3 dB	5.8 dB
TWT fiber panel Panel A, position 6	I-35 fiber panel Panel #2, position 144	15.7 miles	9.45 dB	6.1 dB

BAMC INTERNAL COMMUNICATIONS FOR LIFELINK™

The LifeLink™ terminal at BAMC was placed in the Emergency Department per direction from BAMC staff. SwRI procured and installed equipment as necessary to provide suitable communications between the switch room and the terminal location in the emergency department. The required interconnections between the LifeLink™ communications and terminal equipment within BAMC utilized BAMC internal multi-mode optical fiber and copper cables. During the design work at SwRI for this implementation, discussions between SwRI, BAMC and MRMC staff indicated a potential need to locate multiple terminals at different locations within BAMC. This potential need primarily reflected an

operational scenario that could provide full time coverage of LifeLink™ operations by personnel that would otherwise be in place performing other scheduled duties. It was ultimately decided to not implement more that the first LifeLink™ terminal at BAMC as part of this project, however, this potential need resulted in a significantly changed approach to the BAMC internal communications scheme.

Initially, SwRI had planned to implement a dedicated, specific purpose link between the communications switch room and the emergency department location for the LifeLink™ terminal. In designing a more flexible system to accommodate easier movement of terminals and the inclusion of additional terminals within BAMC, however, an architecture that could support growth and configuration changes was developed and the core of the more flexible configuration is what was installed at BAMC. The system installed at BAMC by SwRI , therefore, can accommodate the addition of a second or more LifeLink™ terminals within the BAMC physical plant. The communications architecture installed for the LifeLink™ system in BAMC, working with the LifeLink™ network through the dedicated fiber connections between BAMC and Transguide™, provide a full Fast Ethernet link (100Mbps) for the BAMC installation. This link will allow multiple nodes within BAMC to link with multiple mobile platforms (such as ambulances) simultaneously in separate conferences if needed in the future. A block diagram of the LifeLink™ communications network installed in BAMC by SwRI is shown in Figure 2.

More specific configuration information for the equipment installed in BAMC's communications switch room (room L62-5) for this project is presented in Figure 3. Photographs of this equipment are presented in Figures 4 and 5. Similarly, configuration information for the LifeLink™ equipment installed in the Emergency Department communications closet (room 120-12) is presented in Figure 6 and photographs of this installation are presented in Figures 7 and 8.

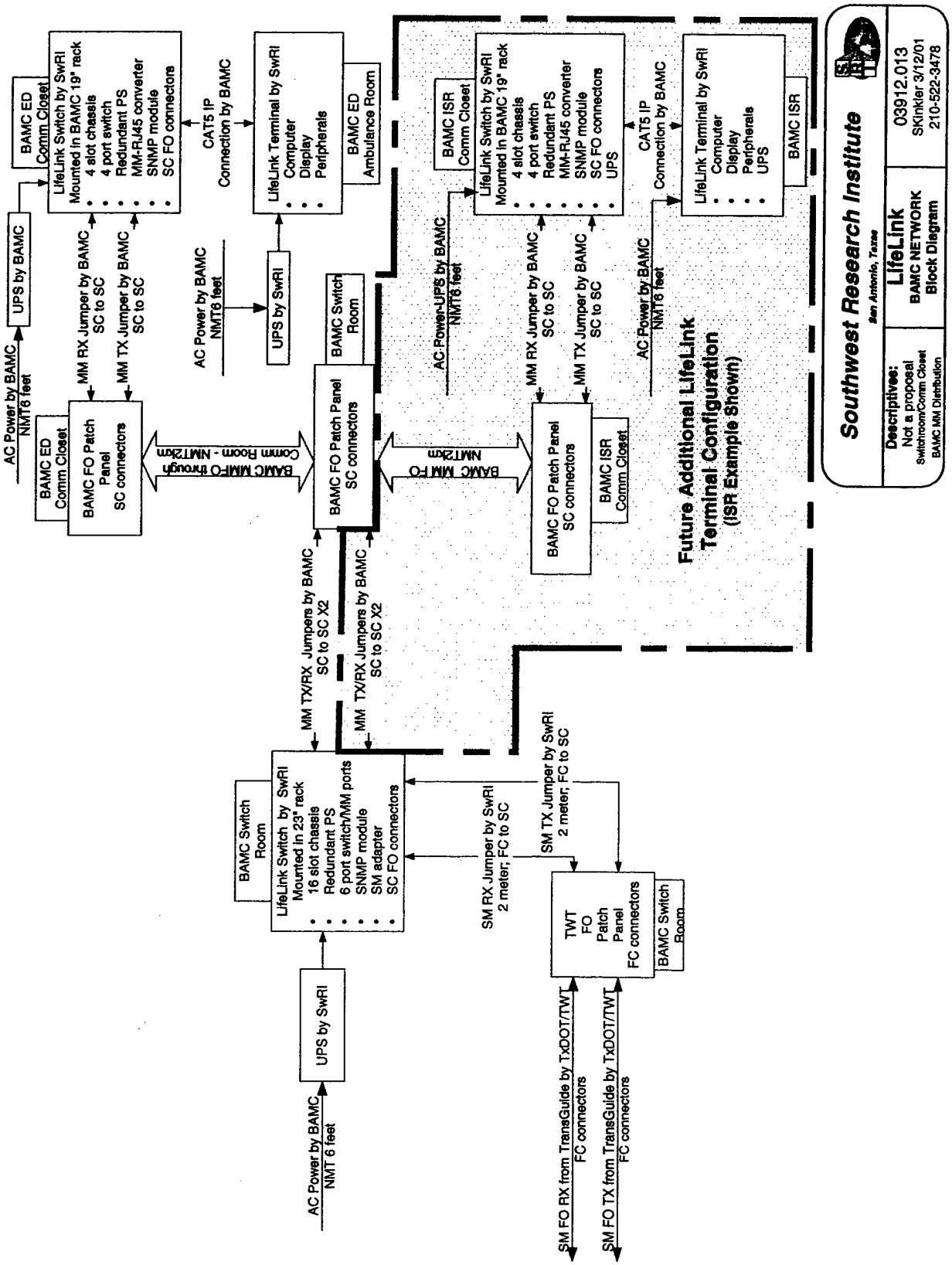

Figure 2. BAMC LifeLink™ System Network Diagram

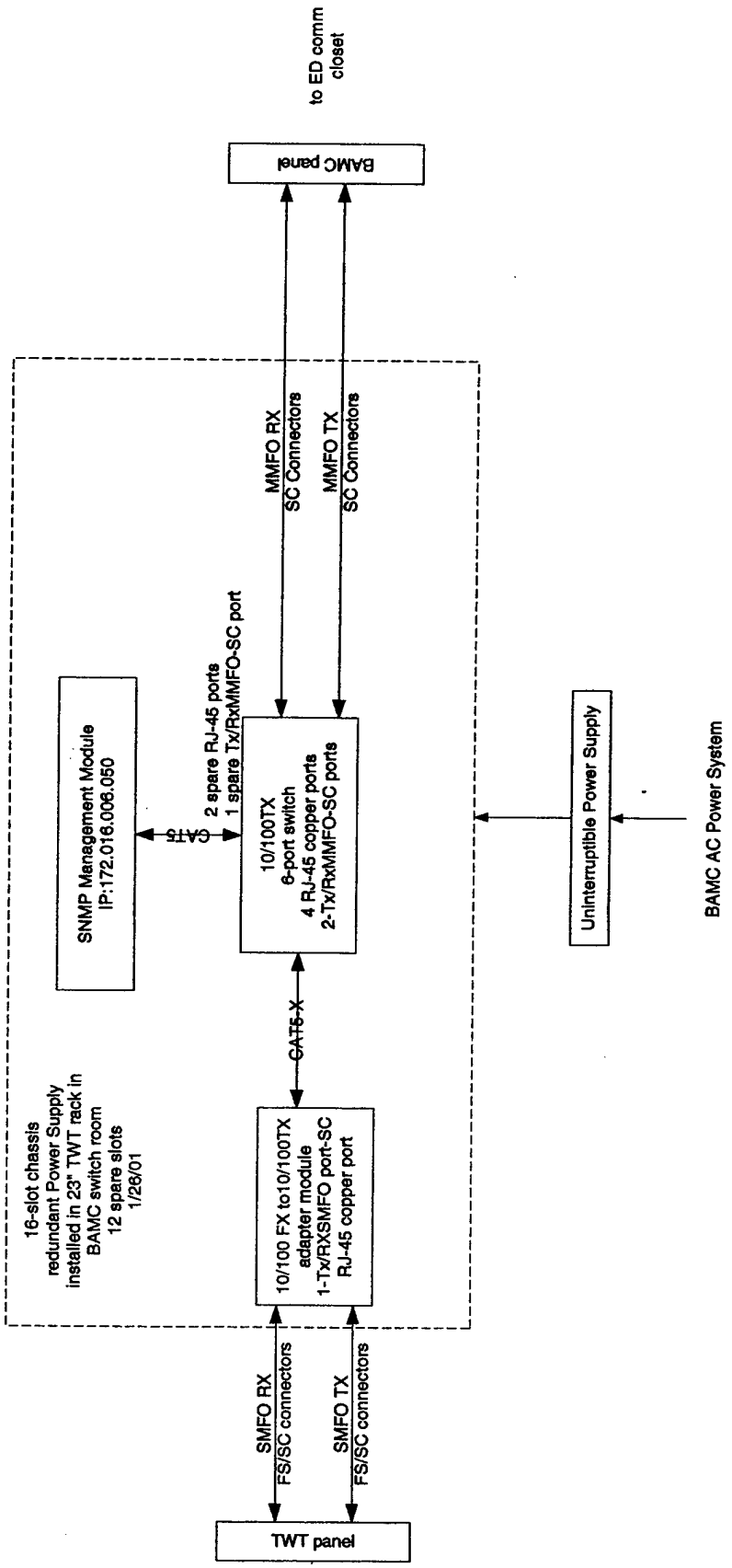

Figure 3. BAMC Communications Switchroom LifeLink™ Equipment Configuration (Room L62-5)

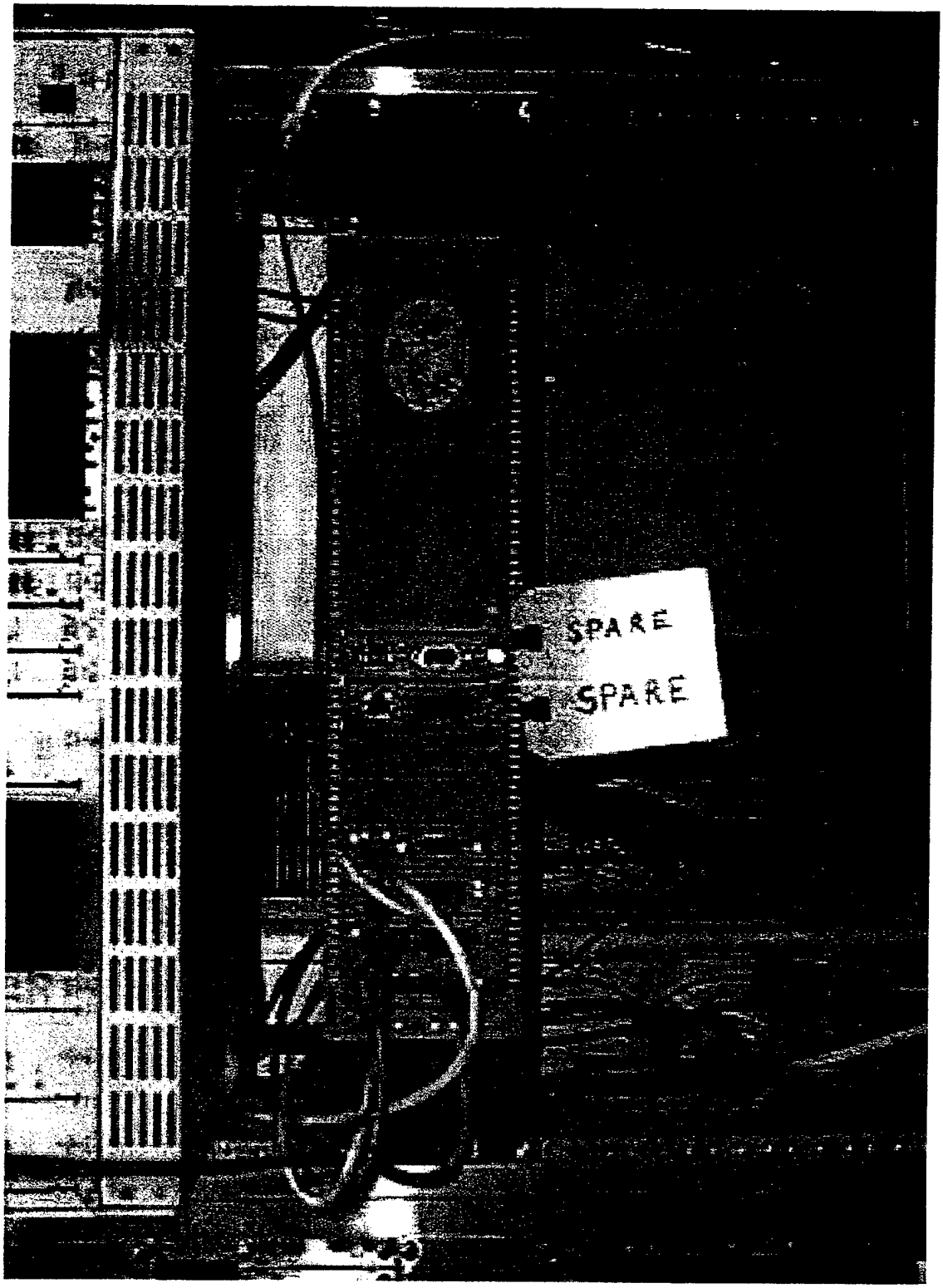

Figure 4. Photograph of LifeLink™ Chassis in BAMC Communications Switchroom (Room L62-5)

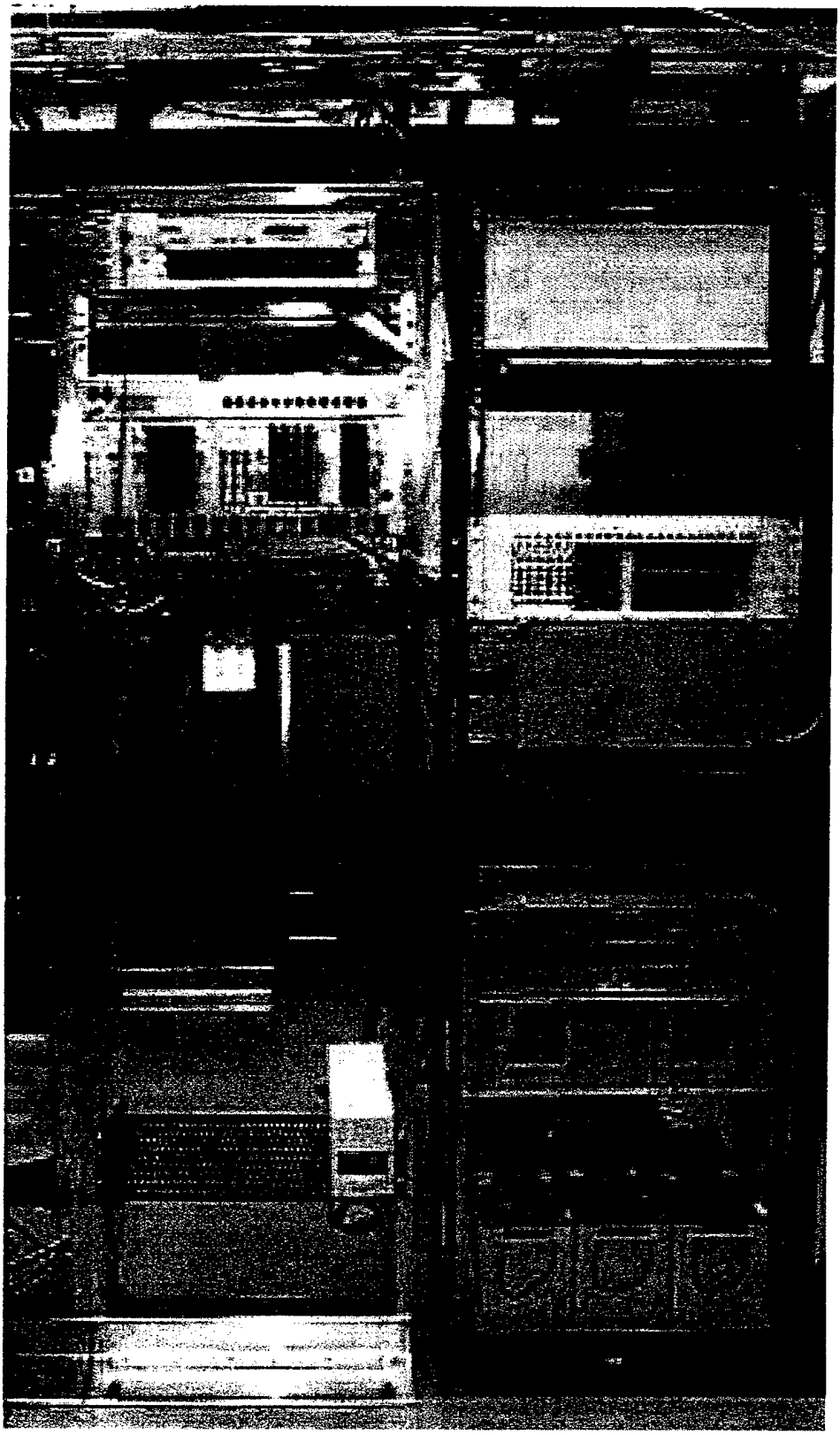

Figure 5. Photograph of LifeLink™ Equipment Showing Relative Location Within BAMC Switchroom (Room L62-5)

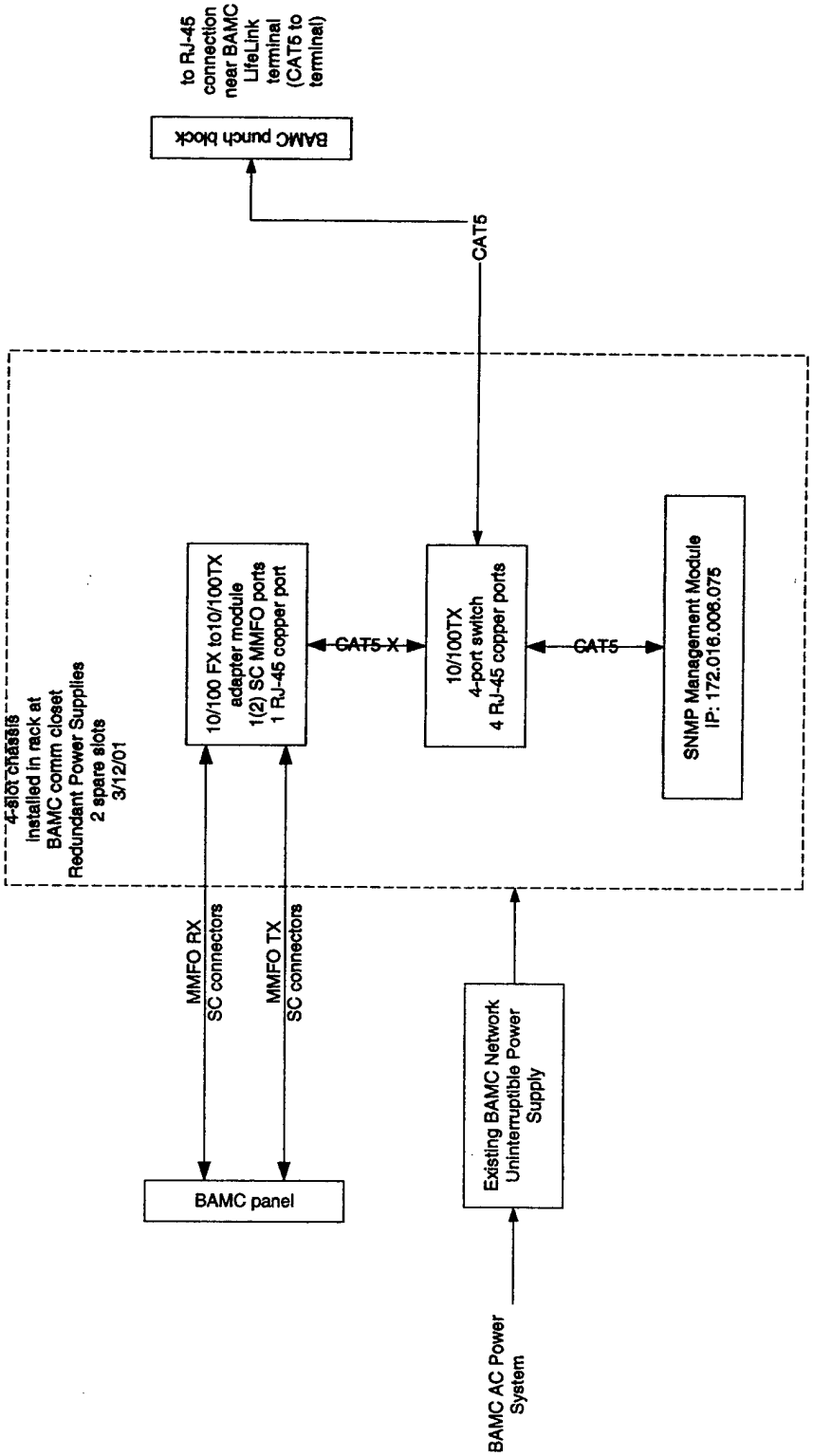

Figure 6. LifeLink™ Equipment Configurations in BAMC Emergency Department Communications Closet (Room120-12)

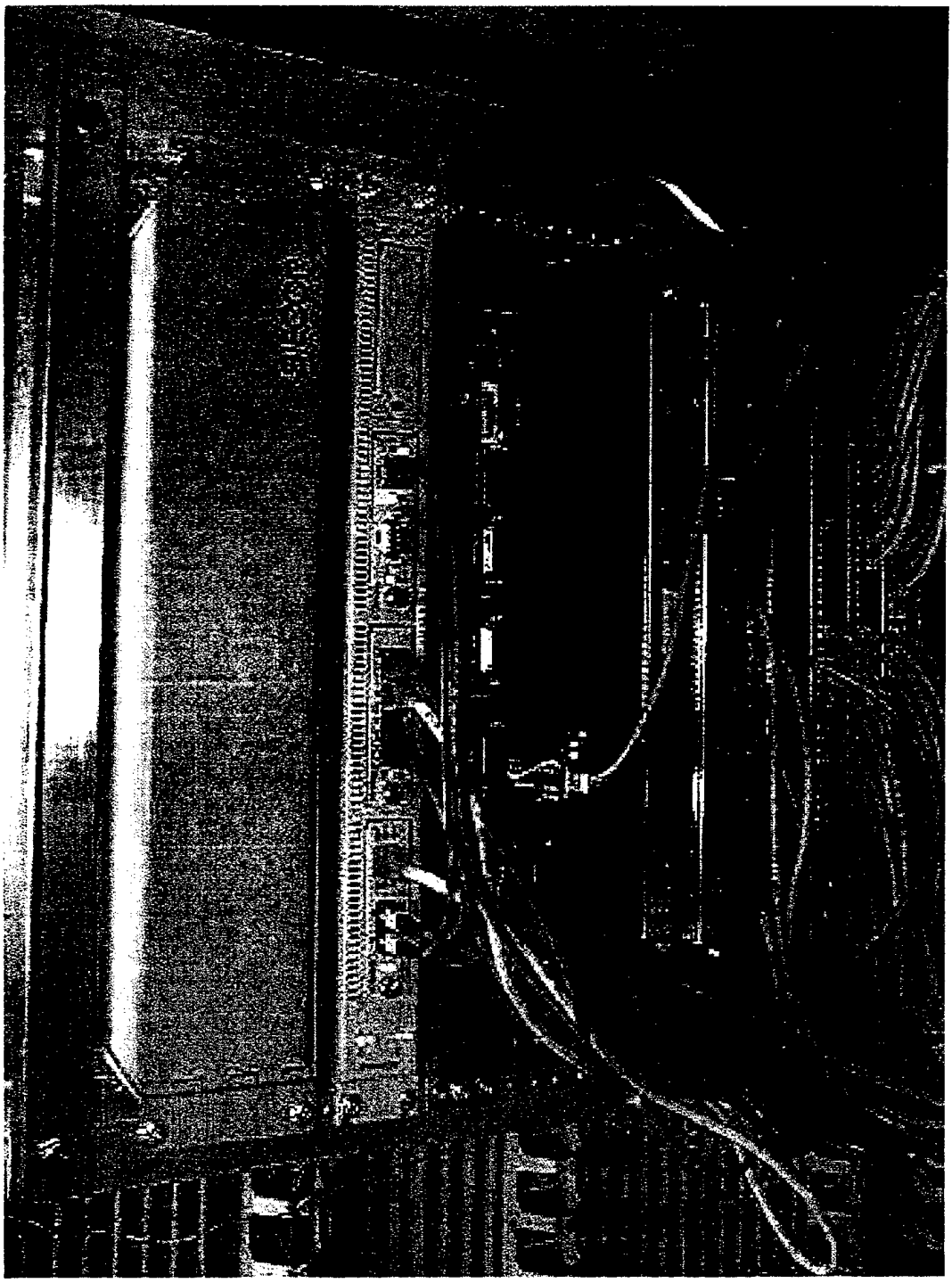

Figure 7. Photograph of LifeLink™ Chassis in BAMC Emergency Department Communications Closet (Room 120-12)

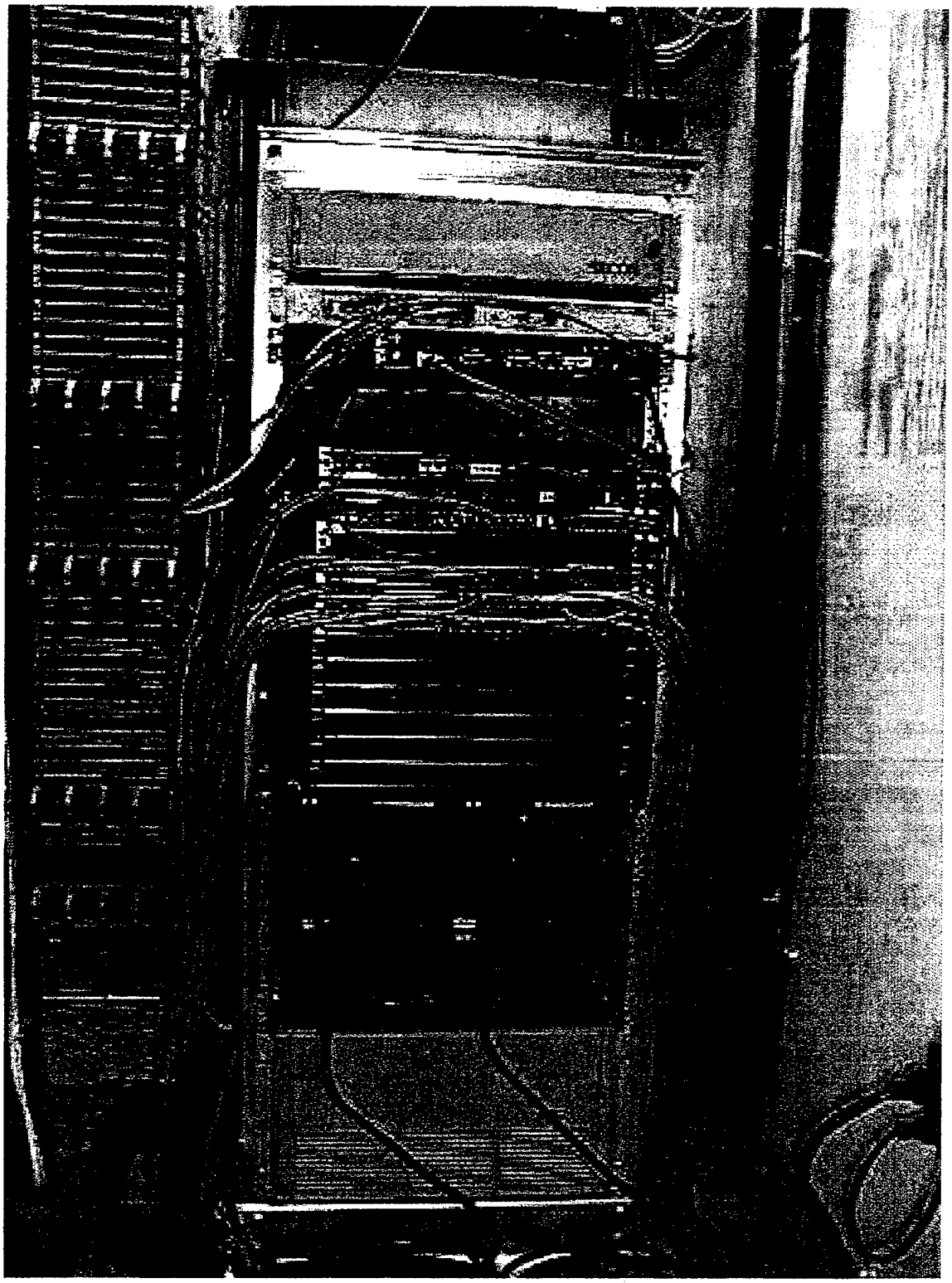

Figure 8. Photograph of LifeLink™ Equipment Showing Relative Location Within BAMC Emergency Department Communications Closet (Room 120-12)

IMPLEMENT A LIFELINK™ TERMINAL AT BAMC

A LifeLink™ terminal was configured to operate within the network. This terminal was installed at BAMC in the "EMT room" as specified by BAMC staff. The EMT room is a small work area between the ambulance loading area and the emergency room at BAMC. For reference, a photo of the ambulance loading area at BAMC showing the relative location of the EMT room is presented in Figure 9. A photograph of the BAMC LifeLink™ terminal located within the EMT room is presented in Figure 10. Discrepancies identified during system installation were documented in nonconformity reports. The reports and their resolutions may be found in Appendix F.

Significant changes in computer and video coder/decoder technologies as used in the LifeLink™ hospital node configuration have occurred recently. It became necessary to investigate and upgrade the LifeLink™ application software to accommodate the new products in the development of a new terminal for ultimate installation at BAMC. SwRI was successful in overcoming these problems with support provided by TxDOT. The computer terminal at BAMC contains a SwRI licensed copy of Windows NT. A legal license was purchased for BAMC for the LifeLink™ terminal. This license and documentation should remain with the BAMC computer.

ADJUST THE LIFELINK™ NETWORK TO INCLUDE THE BAMC TERMINAL

SwRI configured the LifeLink™ network to accommodate the new BAMC connections and terminal during this program. TxDOT purchased new hardware that was required within the Transguide™ system to accomplish this task. The network re-configuration provided full access to all functions within the LifeLink™ system at the BAMC terminal. Simple Network Management Protocol (SNMP) network management access points are resident and accessible within the BAMC communications switch room LifeLink™ equipment, the BAMC Emergency Department communications closet LifeLink™ configuration, and the BAMC LifeLink™ terminal.

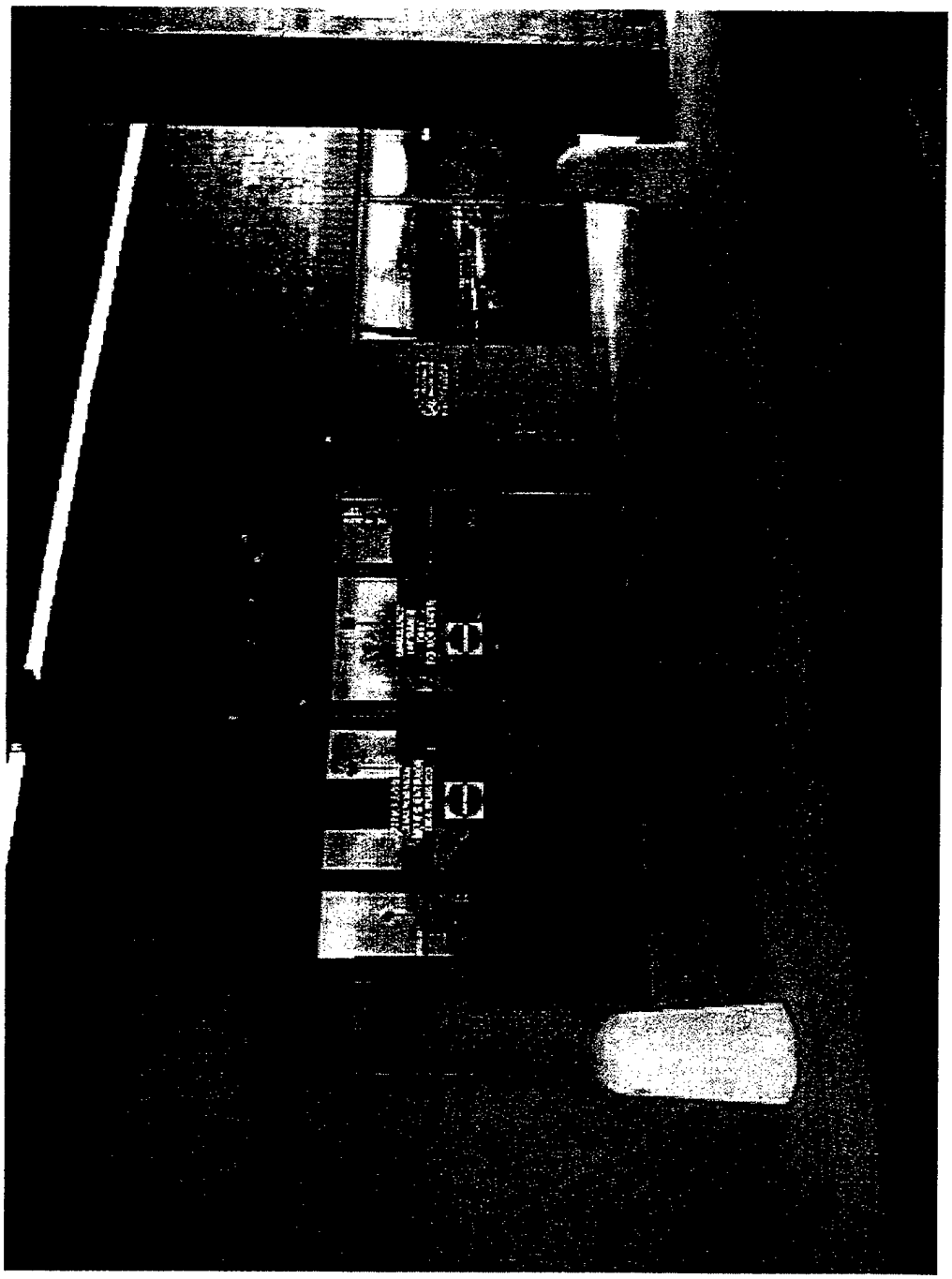

Figure 9. Photograph of BAMC Emergency Department Ambulance Loading Area Showing Relative Location Of LifeLink™ Hospital Terminal In EMT Room With Window At Right Of Doors

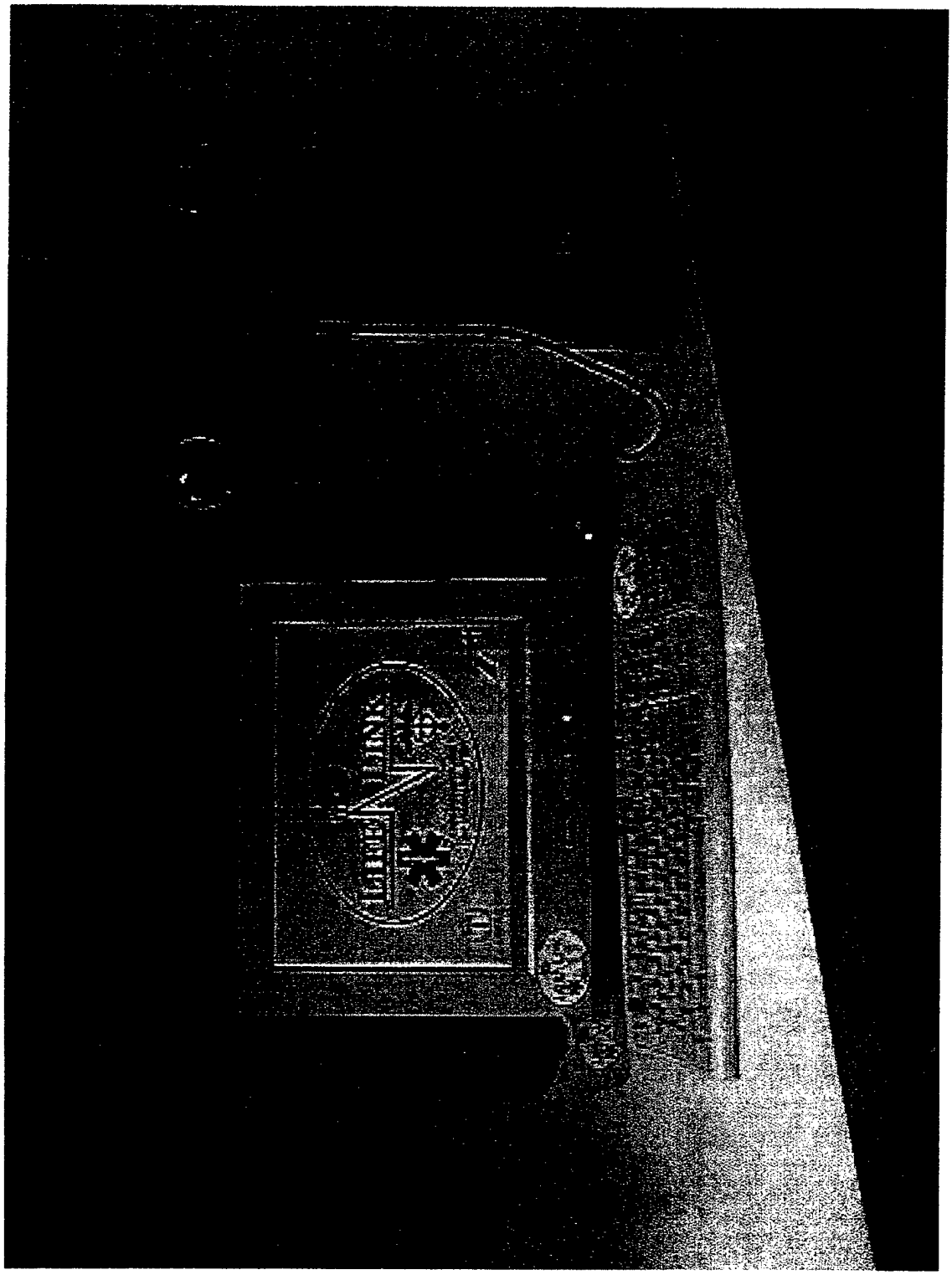

Figure 10. Photograph of LifeLink™ Hospital Terminal inside BAMC Emergency Department

TEST THE LIFELINK™ SYSTEM WITH THE BAMC TERMINAL

Preliminary testing on the LifeLink™ terminal to be installed at BAMC was conducted at SwRI. The terminal was installed at BAMC during February 2001, after the necessary communication equipment was in place at BAMC. Functional testing was performed for the LifeLink™ terminal at BAMC and the LifeLink™ system in general with the BAMC terminal in place, using a San Antonio Fire Department (SAFD) ambulance that was removed from active service for this purpose. During the testing, a Propaq™ EL106 monitor was placed in the ambulance and the vital data telemetry function of the LifeLink™ system was used to send simulated ECG and other data to a Welch Allyn Protocol System Acuity™ display located next to the LifeLink™ Hospital Terminal. Acceptance testing of the BAMC terminal functioning within the LifeLink™ system, again using a borrowed SAFD ambulance, was completed on February 28, 2001. The acceptance test procedures and results may be found as Appendix A.

EXPLORE POTENTIAL USE OF MONITORS SUPPORTING TELEMETRY

The LifeLink™ system was originally developed to operate with either the Protocol Systems Propaq or the Physio-Control LIFEPAK. Both offer real-time continuous transmission of vital signs data. Though neither system is currently deployed in ambulances in San Antonio, the City of San Antonio Fire Department continues to work toward the purchase and use of monitors in city ambulances.

As part of this project, SwRI investigated the willingness of patient monitoring manufacturers to donate monitors for use with the LifeLink™ system and for future Army data collection studies. Discussions were held with Protocol Systems, Zoll Medical, Medtronic Physio-Control, and Agilent Technologies (formerly HP). Zoll, Protocol, and Physio-Control were interested in working with SwRI and the Army on the LifeLink™ program and data collection studies. Agilent does not offer a portable monitor suitable for emergency transport. Protocol supplied at no cost a monitor and Acuity nurses station for the development and testing of the BAMC terminal installation.

Zoll is very interested in supporting a trauma patient data collection study. During a visit to Zoll, the Vice President of Marketing expressed an interest in participating with SwRI and the Army in trauma studies and would be glad to discuss possibilities with the Army. Zoll manufactures the M-Series portable monitor/defibrillator that provides monitoring of the electrocardiogram (ECG, three-lead selectable), blood pressure, oxygen saturation (SpO_2), and also performs defibrillation. The M-Series monitor only has an output signal for ECG. Modifications would need to be made to the M-Series monitor to output other vital measurements continuously.

The LIFEPAK 12 is the latest portable monitor/defibrillator from Physio-Control. It offers both three-lead and 12-lead ECG as well as blood pressure, SpO_2, and end-tidal CO_2. This device is primarily intended for defibrillation. For diagnostic 12-lead ECG, the monitor uses the GE Marquette 12SL™ ECG analysis program. The system provides continuous serial data communication to a central station. Physio-Control is also very interested in supporting a data collection study in San Antonio.

Protocol Systems manufactures the Propaq monitor which offers ECG (three-lead), SpO_2, and blood pressure. It does not provide defibrillation. The Propaq monitor supports continuous serial data communication to a central station. This capability was utilized to include vital signs transmission in the LifeLink™ system. Protocol plans to offer a 12-lead ECG in the near future. Protocol has been very supportive of the LifeLink effort in San Antonio. They loaned SwRI both a portable monitor and central station for installation of the BAMC terminal.

During the LifeLink™ training session with personnel at BAMC, Dr. Sheri Boyd, a cardiologist at BAMC, informed SwRI that BAMC uses Marquette patient monitors. She expressed an interest in using Marquette's 12-lead ECG system in the LifeLink™ ambulance for remote cardiac diagnosis. Marquette offers a portable patient monitor called the Dash 2000 ProMonitor that provides ECG (three-lead), SpO2, and Dynamap blood pressure monitoring. Marquette does not offer a portable 12-lead ECG system. However, it may be possible to integrate the Dash 2000 monitor with the Marquette monitors at BAMC.

SwRI recommends that the Army discuss collaborative efforts for studying trauma with the portable patient monitoring companies. SwRI would be glad to facilitate these discussions as part of a planning effort for a data collection study.

PROVIDE TRAINING, DEMONSTRATION, AND COORDINATION

A training session on the use of the LifeLink™ terminal at BAMC was conducted at BAMC on March 8, 2001. BAMC staff representatives from the Emergency, Trauma, Cardiology, and Surgery Departments were present during the training session. A presentation on the features and functions of the LifeLink™ system and the configuration of a current SAFD LifeLink™ ambulance began the meeting (Appendix B). The presentation concluded with details on user interactions required for operation of the terminal. A paper copy of the presentation slides was given to each meeting attendee for notes and future reference. A one-page summary of the terminal operator interactions and operation instructions (Appendix C) was posted near the terminal and a copy of the abbreviated operating instructions was distributed to each session attendee. A draft copy of the LifeLink™ Hospital Terminal User's Manual (Appendix D) and a VHS video copy of a similar training session were also given to the group for later study and reference. Copies of each of the referenced printed documents are attached to this report for reference.

At the conclusion of the meeting, each attendee was given the opportunity to use the terminal in a conference and interact with SwRI staff operating the LifeLink™ network management terminal at Transguide™, which was configured as an ambulance node for this training event.

Discussions were also held with staff at BAMC and with SAFD EMS staff regarding coordination and use of the LifeLink™ system among multiple SAFD EMS ambulances and the two hospitals (BAMC and University Hospital) that now have LifeLink™ terminals.

There are a number of discussions and considerations under way regarding the organization and implementation of adjustments to the structure and operation of pre-hospital medical oversight and the use of the LifeLink™ system for that purpose falls within that organization. Many issues are being

considered, and discussions have included potential plans for a central answering and call screening point for medical oversight, including the LifeLink™ system, with call hand-off or consulting, on a selected basis, to receiving hospitals or appropriate medical specialists. Additionally, a diffusion of medical oversight responsibilities to include participation in pre-hospital medical oversight by BAMC staff and others is being discussed and considered. Ultimately, operational details and coordination for the use of the LifeLink™ system within the pre-hospital medical oversight framework will be subject to any organization implementations and agreements formed by the involved agencies and medical institutions.

An operational demonstration of the LifeLink™ system including the terminal at BAMC and a borrowed SAFD LifeLink™ ambulance was conducted for BAMC staff on March 1, 2001. BAMC staff members were able to interact with and use the system in a mobile ambulance setting as well as at the fixed Hospital Terminal within BAMC.

Of particular note was a demonstration of the use of the LifeLink™ system by interested staff from BAMC's Cardiology service, wherein a brief experiment to use the LifeLink™ system was conducted. During this demonstration, the video signal from a portable ultrasound echocardiograph instrument was substituted for the video signal from the LifeLink™ camera aboard an ambulance.

The video display, obtained by the use of the portable instrument during an examination of a mock "patient" in the ambulance, was thereby transmitted over the LifeLink™ network and presented to other BAMC Cardiology staff seated at the LifeLink™ Hospital Terminal at BAMC's ED. Coordination among the experiment participants and descriptions of the observed display characteristics were accomplished over the LifeLink™ audio channel. During this demonstration, a Propaq™ EL106 monitor was placed in the ambulance and the vital data telemetry function of the LifeLink™ system was used to send simulated ECG and other data to a Welch Allyn Protocol Systems Acuity™ display located next to the LifeLink™ Hospital Terminal. As a result of this work, plans are being made to conduct additional trials using the LifeLink™ system for these types of advanced telemedicine applications. Figures 11 through 14 are snapshots taken during the remote echocardiograph experiment using the LifeLink™ system and are included for reference.

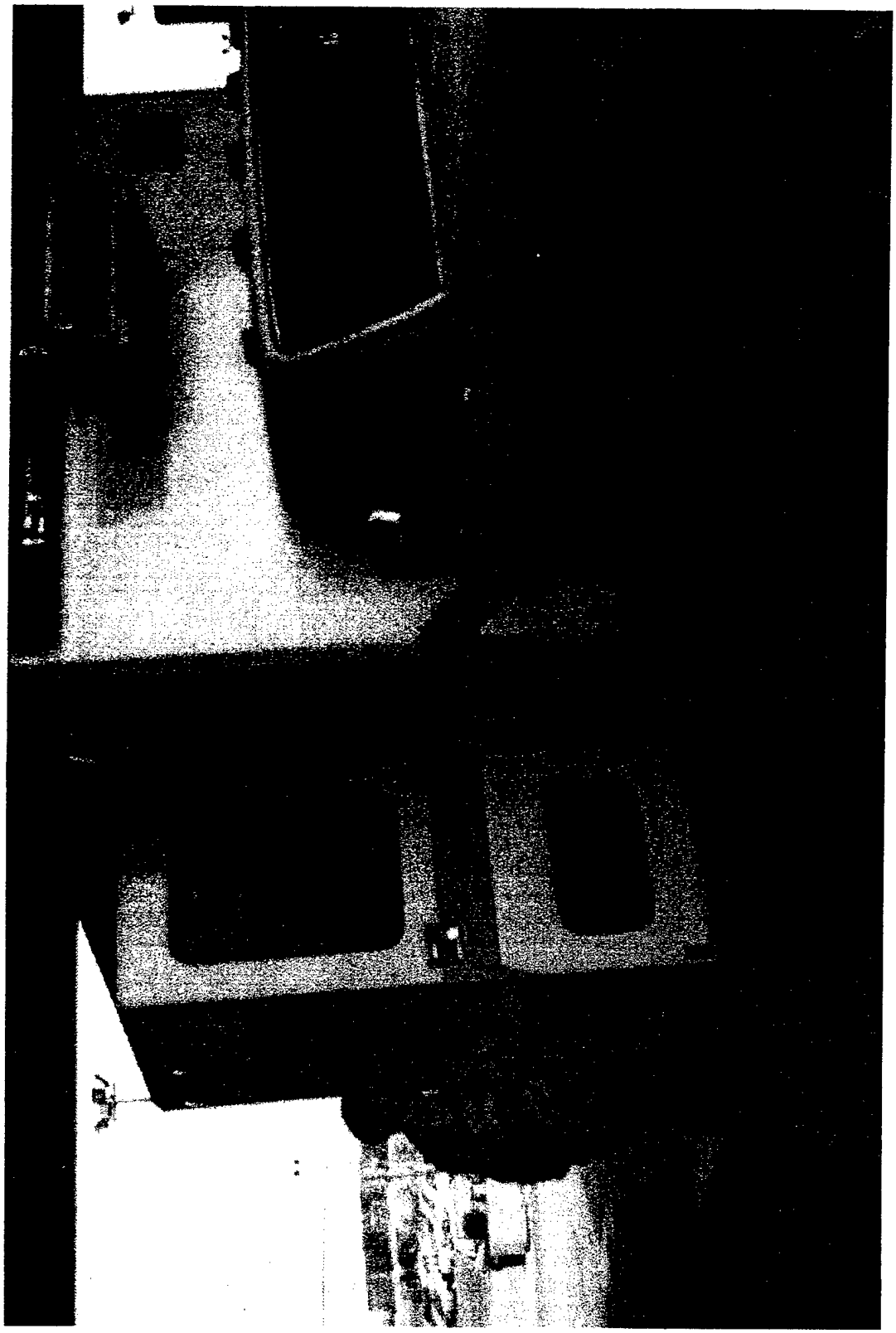

Figure 11. Photograph of San Antonio Fire Department LifeLink™ Ambulance Used in Tests and Demonstrations

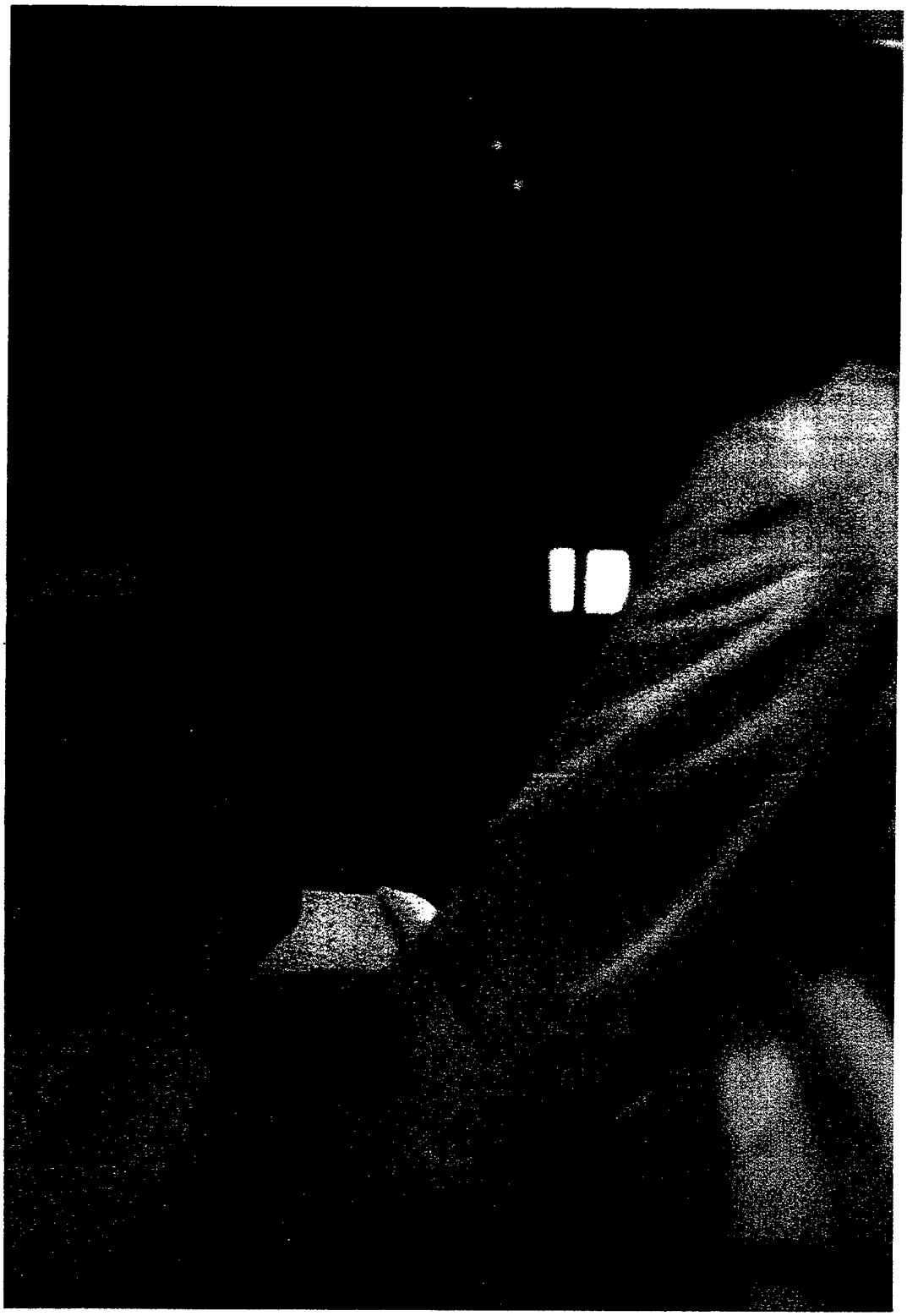

Figure 12. BAMC Cardiology Staff Performing Remote Echocardiograph Exam In LifeLink™ Ambulance

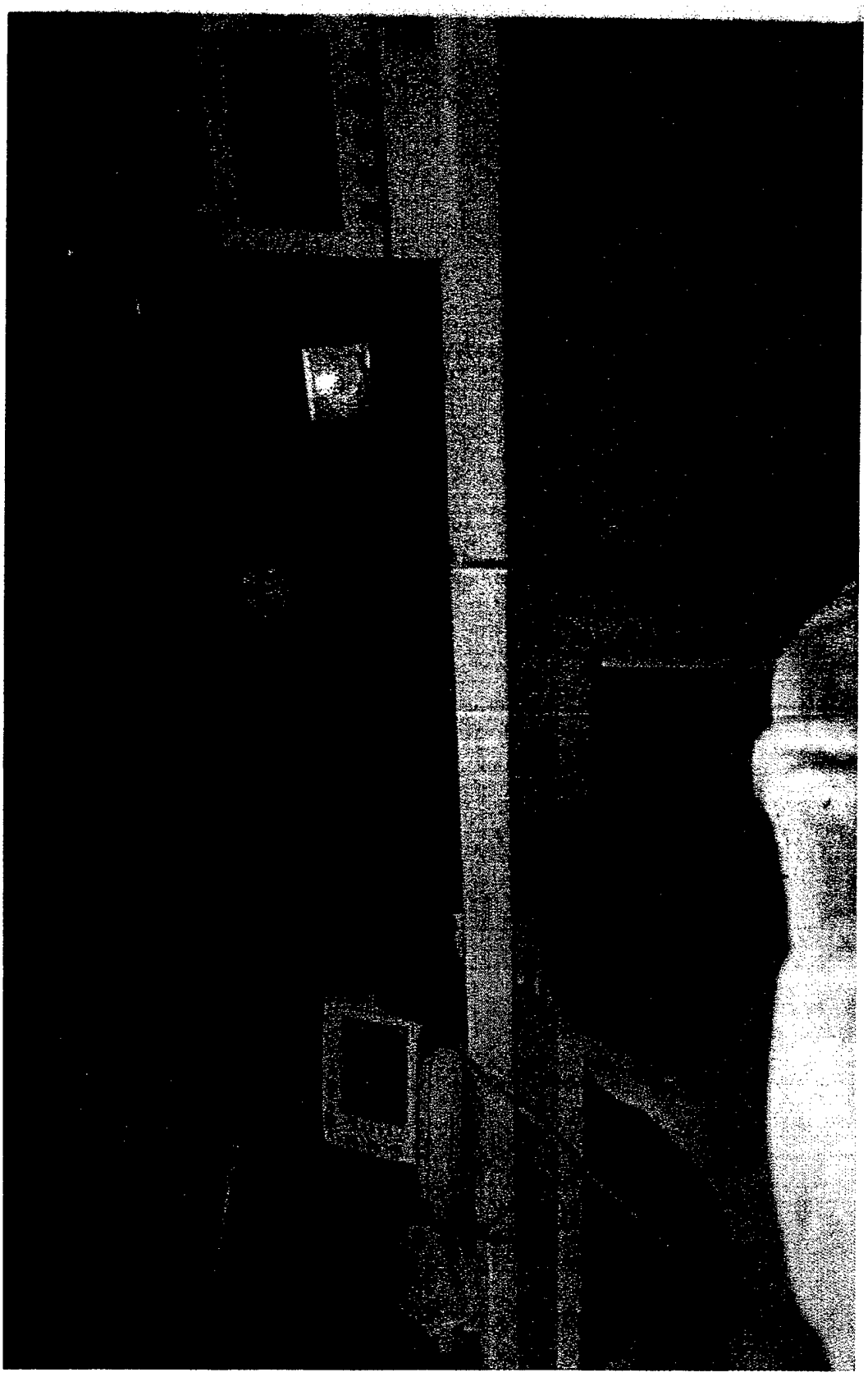

Figure 13. Interior of SAFD LifeLink™ Ambulance during Remote Echocardiography Demonstration

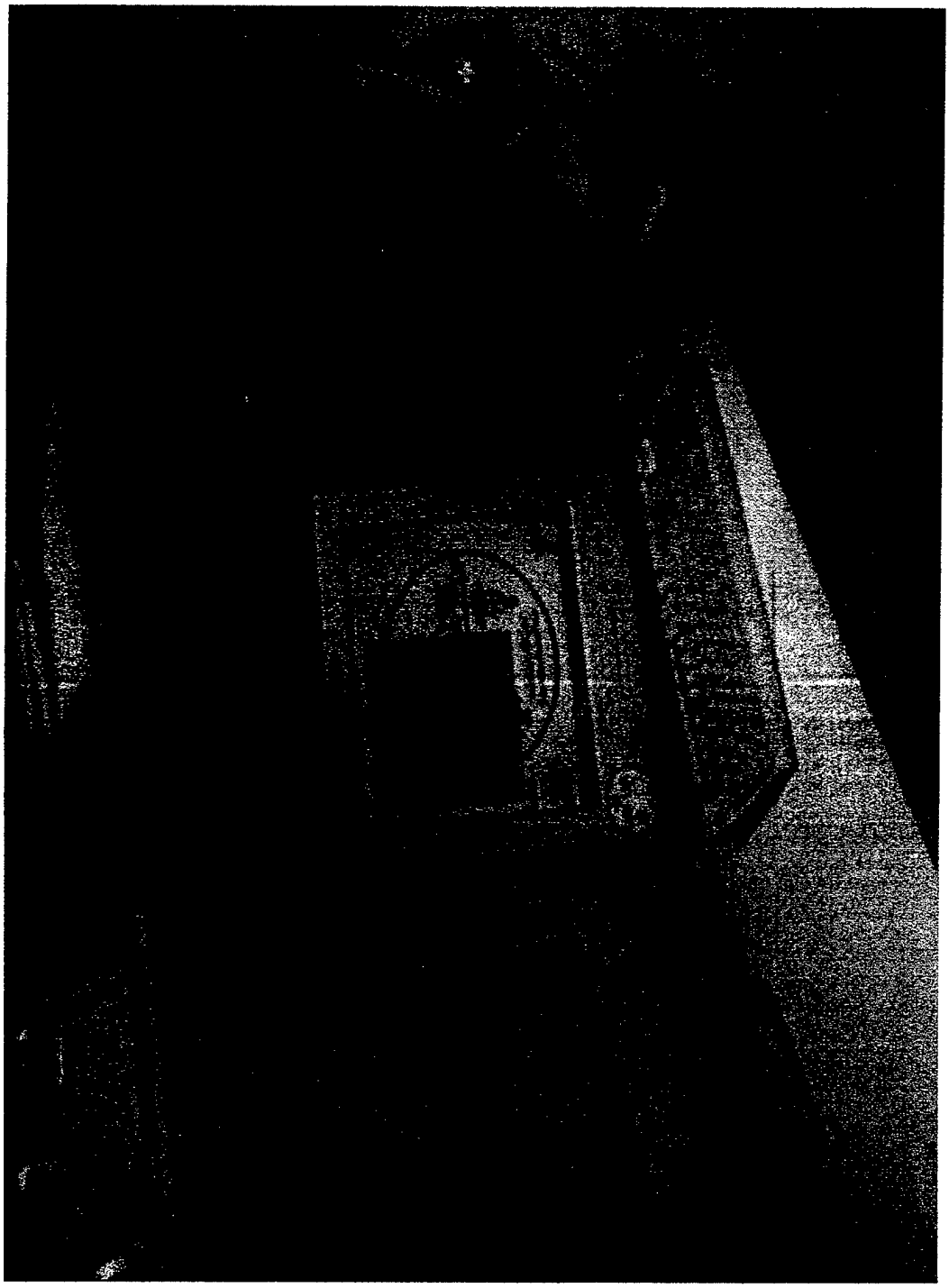

Figure 14. BAMC Cardiology Staff Seated At BAMC LifeLink™ Terminal during Remote Echocardiography Demonstration

CONCLUSIONS AND RECOMMENDATIONS

The objective of this work was to implement a functional LifeLink™ Hospital Terminal at BAMC, including the implementation of suitable communications means between the selected terminal location at BAMC and the LifeLink™ network equipment located at TxDOT's Transguide™ facility in San Antonio, Texas. Work to design the components of the new subsystems; procure needed equipment and communications media; configure and implement the required equipment at BAMC and in the balance of the network; and test, demonstrate, and provide related training and coordination was accomplished as reported herein.

Ongoing discussions and planning is underway to use the new terminal at BAMC in conjunction with the growing LifeLink™ field system in further telemedicine research activities and in general use in pre-hospital medical oversight in medical emergencies. These considerations were stimulated or facilitated, at least in part, by the availability of the LifeLink™ terminal at BAMC as a result of this project.

The technical infrastructure for the LifeLink™ system within BAMC resulting from this work is designed to accommodate straightforward re-configuration and expansion of LifeLink™ deployments within BAMC, easily accommodating the movement of terminal locations and the addition of more LifeLink™ terminals within the hospital complex. The capacity of the communications link between BAMC and the LifeLink™ network at Transguide™, which was implemented as part of this project, will support simultaneous operations of multiple LifeLink™ Hospital Terminals linked to multiple field ambulances.

SwRI offers three simple recommendations as uses of the LifeLink™ Hospital Terminal at BAMC are planned and considered:

1. The location of the LifeLink™ Hospital Terminal at BAMC precludes notification of staff in the ED by the intended audible and visual means designed into the LifeLink™ system for this purpose. The room where the terminal is located is not regularly staffed and is remote from

areas that are typically staffed in the ED. It is recommended that consideration be given to re-locating the terminal to an area where staff will be available to see and hear the incoming call notification alerts. Alternately, a means to provide an alternate remote incoming call alert mechanism may be implemented in an area that is typically staffed such that staff will be alerted to come to the terminal location when called by an ambulance crew or researcher.

2. It is recommended that a telephone capable of operating in the telephone system within BAMC and connecting to the Public Switched Telephone Network should be located near the BAMC LifeLink™ Hospital Terminal. The telephone should be available to facilitate coordination and consulting by the users of the terminal during medical oversight, research, and any other uses of the terminal.
3. The current location of the LifeLink™ Hospital Terminal at BAMC may not allow controlled access to the terminal screen showing remote video coming from the field and therefore may not provide adequate patient privacy. Persons within the room that may not be associated with the use of the terminal may easily view the screen and listen to the operator's voice. Persons outside the building near the ambulance loading area may also easily view the terminal screen through a large window. It is recommended that consideration be given to locating the LifeLink™ Hospital Terminal to a more suitable location or that access control measures be considered as the system becomes used for patient care or research.

APPENDIX A. Acceptance Test Plan and Results

Controlled Document # 3912-0012

Acceptance Test Plan - Test Results 3912-XX

~~CONTROLLED COPY~~ Final
3/1/01

~~3912-009~~ Final
3/1/01

IMPLEMENTATION OF LIFELINK CONNECTIONS AT BROOKE ARMY MEDICAL CENTER (BAMC)

Acceptance Test Plan

Version 1.0

SwRI Project No. 10-03912
Basic Contract Number: V674P-2995
Order Number 674-W00138

February 28, 2001

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Acronym List

ATMS	Advanced Traffic Management System
codec	Coder/Decoder
kbps	Kilo bits per second
L1TC	Level 1 trauma care
LAN	Local Area Network
MDI	Model Deployment Initiative
PC	Personal Computer
SNMP	Simple Network Management Protocol
SwRI	Southwest Research Institute
TOC	TransGuide Operations Center
TxDOT	Texas Department of Transportation
VC	Videoconferencing
WDM	Wave Division Multiplexer
WEB	Wireless Ethernet bridge

1. Scope

This document describes the tests to be performed and the results that are required in order to verify that the terminal developed and installed at Brooke Army Medical Center (BAMC) is constructed and operates in accordance with the requirements of the LifeLink system as currently deployed in San Antonio, Texas and operated and maintained by the Texas Department of Transportation.

1.1 Identification

The tests described in the following sections refer to the LifeLink system in San Antonio, Texas. LifeLink system descriptions (and testing) are generally divided into five sections:

- The ambulance configuration
- The hospital configuration
- The roadside fiber hub configuration
- The TransGuide Operations Center (TOC) configuration
- System functionality

1.2 System Overview

The basic purpose of the LifeLink System is to provide two-way video and audio conferencing and one-way vital statistics data telemetry capabilities between ambulances responding to major accidents and physicians at Level 1 Trauma Care (L1TC) facilities such that early assessment and treatment may be initiated in the field.

The LifeLink System provides a distributed mobile Ethernet Local Area Network (LAN) designed to link San Antonio Fire Department (SAFD) ambulances on or near San Antonio's freeway system with a L1TC provider in the city. The link utilizes the facilities and roadside fiber-optic network of the TransGuide Advanced Traffic Management System (ATMS). The system provides real-time videoconferencing between an ambulance and emergency medical personnel at the L1TC facility. Additionally, the ambulance crew can use optional portable medical data instruments to also send vital statistics data to terminal equipment in the L1TC facility over the LifeLink communications system.

1.3 Goals and Objectives

The LifeLink System offers the opportunity for early intervention by L1TC facility personnel and provides L1TC facilities with additional information about the condition of incoming patients prior to arrival.

The goal of this ATP is to demonstrate the capability of the terminal installed at BAMC to operate within the LifeLink environment and to validate that it meets the requirements sufficiently to provide all designed attributes for a LifeLink hospital terminal. The test cases contained in this ATP have been directly derived from requirements and other documents developed for the LifeLink system. This "black box" testing strategy is designed to discover faults of omission by identifying which requirements have and have not been fulfilled.

1.4 Referenced Documents

- Southwest Research Institute, *Proposal for the Model Deployment Initiative System Integration*, SwRI Proposal No. 10-20342, November 1996.
- Texas Department of Transportation, *Request for Offer (RFO) for the Model Deployment Initiative System Integration, 60115-7-70030*, Specification No. TxDOT 795-SAT-01, October 1996.
- Southwest Research Institute, *LifeLink System Design Document*, Project #10-8684, December 1997.

2. Acceptance Test Methods and Procedures

This section describes the test methods and procedures for executing the LifeLink Hospital Node ATP. The test cases to be completed during execution of this ATP have been designed to demonstrate that the hospital node under test meets the requirements specified in the referenced documents.

2.1 Test Identification

The following sections describe specific tests that shall be carried out to demonstrate that the system meets required specifications. The preparation required for each test, the specific requirements to be verified, the test conditions, and the expected results are described.

The specific requirements to be verified are derived from, and cross-referenced to, specific requirements listed in the *LifeLink System Design Document*, December 1997. The tests will be identified with a project unique identifier. This identifier will have the following format:
<System Mnemonic>-<Subsystem Mnemonic>-<Test Number>

System Mnemonic

The system mnemonic uniquely identifies the LifeLink System to distinguish its acceptance tests from the tests for other systems. The system mnemonic for the LifeLink System is *LL*.

Subsystem Mnemonic

The mnemonic for LifeLink Hospital Node subsystem tests is:
HOSP Hospital Subsystem Requirements

Test Number

The tests are numbered sequentially within a given subsystem.

The requirements are addressed as follows:

- Section 2.4 – All requirements related to the hospital subsystem.
- Section 2.5 – System level requirements which involve operations and interfaces for the hospital subsystem.

2.2 Test Case Design

Test cases will be implemented using one or more of the following qualification methods:

- Inspection. The visual examination of computer code documentation, hardware, etc.
- Demonstration. The operation of the system, or a part of the system, that relies on observable

functional operation not requiring the use of instrumentation, special test equipment, or subsequent analysis.

- Test. The operation of the system, or a part of the system, using instrumentation or other special test equipment to collect data for later analysis.
- Analysis. The process of accumulating data obtained from other qualification methods. Examples are reduction, interpretation, or extrapolation of test results.

2.3 Problem Reporting

Problems detected during execution of the ATP will be classified by category as follows:

- Software problem. The software does not operate according to the specified requirements and the requirements are correct.
- Hardware problem. The hardware does not operate according to the specified requirements and the requirements are correct.
- Documentation problem. The software/hardware does not operate according to the specified requirements but the software/hardware operation is correct.
- Design problem. The software/hardware operates according to the specified requirements but a design deficiency exists. The design deficiency may not always result in a direct observable operational problem but possesses the potential for creating further problems.

Problems detected during execution of the ATP will be classified by priority as follows:

- Priority 1: A problem that prevents the accomplishment of an operational or essential capability.
- Priority 2: A problem that results in user/operator inconvenience or annoyance but does not affect required operational or essential capability.
- Priority 3: Any other effect.

Retesting will consist of repeating a subset of the test cases after changes have been made to correct problems found in previous testing. Retesting will be considered complete if: (a) test cases that revealed problems in the previous testing have been repeated and the results have met acceptance criteria, and (b) test cases that revealed no problems during the previous testing but test functions that are affected by the corrections have been repeated and the results have met acceptance criteria.

2.4 LL-HOSP

This test verifies hospital subsystem requirements for the LifeLink System.

2.4.1 Hardware Preparation

Hardware installed in operating configuration.

2.4.2 Software Preparation

Software installed in operating configuration.

2.4.3 Other Pre-Test Preparation

None.

2.4.4 Test Description

The following test cases are implemented under this test:

LL-HOSP-1	Verifies the equipment specifications of the hospital subsystem.
LL-HOSP-2	Verifies the user-interface requirements of the hospital subsystem.
LL-HOSP-3	Verifies the location/mounting requirements of the hospital subsystem.

2.4.4.1 LL-HOSP-1

This test verifies the equipment specifications of the hospital subsystem. This test may be accomplished with the hospital subsystem operating within a deployed LifeLink network or in a laboratory using a LifeLink network simulation.

2.4.4.1.1 Requirements Addressed

LL-HOS-001	The L1TC facility subsystem shall include one PC.
LL-HOS-002	The L1TC facility PC shall provide necessary connections and ports for connection to fixed location vital statistics monitoring equipment.
LL-HOS-003	The L1TC facility PC shall support 10BaseT Ethernet connectivity.

2.4.4.1.2 Prerequisite Conditions

Hardware and software preparation complete.

2.4.4.1.3 Test Inputs

Documentation.

2.4.4.1.4 Test Results Evaluation

Test results will comply fully with referenced requirements.

2.4.4.1.5 Test Procedure

Using applicable documentation verify:

1) the computer is a PC with the following components:
   a) a PCI port available for a codec,
   b) a 10 Mb Ethernet adapter with an RJ-45 connector,
   c) a DB-9 serial port available for vital data connection;
2) the camera resolution is at least CIF (at least 240 horizontal scan lines);
3) the headset has both speakers and a microphone.

2.4.4.1.6 Assumptions and Constraints

None.

2.4.4.1.7 Test Results

Yes	No	
☒	☐	Does the computer meet the required specifications?
☒	☐	Does the camera meet the required specifications?
☒	☐	Does the headset meet the required specifications?

☒ **PASS** ☐ **FAIL** **SwRI:** [signature] **Date:** 2/28/01

2.4.4.2 LL-HOSP-2

This test verifies the user-interface requirements of the hospital subsystem. This test may be accomplished with the hospital subsystem operating within a deployed LifeLink network or in a laboratory using a LifeLink network simulation.

2.4.4.2.1 Requirements Addressed

LL-HOS-005 User interface to the LifeLink L1TC facility computer shall limit (to a practical extent) the actions required to answer, transfer, or terminate a videoconferencing session.

LL-GEN-003 A full-duplex videoconferencing session with an ambulance may be transferred to another L1TC facility.

2.4.4.2.2 Prerequisite Conditions

Hardware and software preparation complete.
Link hospital subsystem running in operational mode.
The hospital subsystem has completed conferencing initialization.
A conference has been initiated by an ambulance node.

2.4.4.2.3 Test Inputs

None.

2.4.4.2.4 Test Results Evaluation

The LifeLink hospital system is expected to require minimal interaction with the user.
The control of the conference is expected to be transferable to another node.

2.4.4.2.5 Test Procedure

1. Acknowledge the incoming conference by pressing one (1) key marked "Enter".
2. Initiate a consulting node by pressing one (1) key marked "Add Consult" (F6).
3. Select a L1TC facility node by entering the two (2) digit code on the keyboard or selecting the default node (no buttons pressed).
4. Confirm the selection by pressing one (1) button marked "Enter".
5. Verify the connection successfully completed.
6. Initiate a transfer by pressing one (1) key marked "Call Transfer" (F5).
7. Select a L1TC facility node by entering the two (2) digit code on the keyboard or selecting the default node (no buttons pressed).
8. Confirm the selection by pressing one (1) button marked "Enter".
9. Verify the transfer is successfully completed and the original node has terminated its connection.
10. Terminate the conference by pressing one (1) button marked "F1" (Initiate/Terminate).

2.4.4.2.6 Assumptions and Constraints

The hospital computer is always on with a guaranteed power source.

2.4.4.2.7 Test Results

Yes	No	
☒	☐	Does the acknowledgement of an incoming conference require only one (1) key press?
☒	☐	Does the consulting mode activate within two (2) to four (4) key entries?
☒	☐	Does the transfer function activate within two (2) to four (4) key entries?
☒	☐	Does the conference terminate with only one (1) key press?

☒ **PASS** ☐ **FAIL** **SwRI:** Eric Kulas **Date:** 2/28/01

2.4.4.3 LL-HOSP-3

This test verifies the location requirements of the hospital subsystem.

2.4.4.3.1 Requirements Addressed

LL-HOS-004 The L1TC facility PC shall provide unobstructed access to other L1TC facility equipment or walkways.

2.4.4.3.2 Prerequisite Conditions

Hardware and software preparation complete.

2.4.4.3.3 Test Inputs

None.

2.4.4.3.4 Test Results Evaluation

Test results will comply fully with referenced requirements.

2.4.4.3.5 Test Procedure

Inspect the location of the LifeLink hospital subsystem to ensure unobstructed access to other L1TC facility equipment or walkways.

2.4.4.3.6 Assumptions and Constraints

None.

2.4.4.3.7 Test Results

Yes	No	
☒	☐	Does the LifeLink hospital subsystem location meet the required specification?

☒ **PASS** ☐ **FAIL** **SwRI:** _____ **Date:** 2/28/01

2.5 LL-SYST

This test verifies system requirements for the LifeLink program that involve operations and interfaces for the hospital subsystem.

2.5.1 Hardware Preparation

Hardware installed in operating configuration.

2.5.2 Software Preparation

Software installed in operating configuration.

2.5.3 Other Pre-Test Preparation

None.

2.5.4 Test Description

The following test cases are implemented under this test:

LL-SYST-1	Verifies the configuration of the system.
LL-SYST-2	Verifies the operation of the system.
LL-SYST-3	Verifies the vital data transfer of the system.
LL-SYST-4	Verifies the mobile operation of the system.
LL-SYST-5	Verifies the call-busy/call-waiting of the system.
LL-SYST-6	Verifies the call-transfer/call-consult of the system.

2.5.4.1 LL-SYST-1

This test verifies the configuration of the system.

2.5.4.1.1 Requirements Addressed

LL-SYS-001	Each end of the videoconference shall provide a full-screen view of the received video with a smaller view containing the local image that is being transmitted.
LL-SYS-003	The computer at each end of the videoconference shall be configured to perform automatic operating system startup and application startup.
LL-SYS-006	The system shall provide voice contact between the controlling physician and the ambulance LifeLink system operator via a single headset provided at each end of the videoconference.
LL-SYS-008	The videoconference shall provide : A minimum resolution of CIF (352x240 pixels), Scalability to full screen, Display of the transmitted image, Operation within the radio bandwidth.

2.5.4.1.2 Prerequisite Conditions

Hardware and software preparation is complete.
Both systems are in the "off" state.

2.5.4.1.3 Test Inputs

Documentation.

2.5.4.1.4 Test Results Evaluation

Test results will comply fully with referenced requirements.

2.5.4.1.5 Test Procedure

1) At the Ambulance:
   a) Activate the system by pressing the button labeled "Power On".

2) At the L1TC facility:
   a) Activate the system by pressing the computer power button.
   b) Verify the system startup progresses without user intervention until the system is ready to receive a conference.

3) At the Ambulance
   a) Initiate the conference.
   b) Verify the remote image is displayed on the large monitor.
   c) Verify the local image appears on the local-image (small) monitor.
   d) Verify the presence of a headset for audio connectivity.

4) At the L1TC facility:
   a) Acknowledge the conference.
   b) Verify the remote image is scaled to full screen.
   c) Verify the local image appears in a Picture-in-Picture display.
   d) Verify the minimum resolution by toggling the size to CIF.
   e) Verify bandwidth usage with radio bandwidth by inspecting the "Bit Rate" setting.
   f) Verify the presence of a headset for audio connectivity.

2.5.4.1.6 Assumptions and Constraints

None.

2.5.4.1.7 Test Results

Yes	No	
☒	☐	Does the hospital computer automatically progress to a ready state upon startup?
☒	☐	Does the videoconference meet the required specifications?

☒ ☐ Does the hospital subsystem display a full screen view of the received image?

☒ ☐ Does the hospital subsystem display a smaller local view of the transmitted image?

☒ ☐ Does the system contain headsets as specified?

☒ **PASS** ☐ **FAIL** **SwRI:** _____ **Date:** 2/28/01

2.5.4.2 LL-SYST-2

This test verifies the operation of the system.

2.5.4.2.1 Requirements Addressed

LL-GEN-001 The system shall provide an Ethernet communications network, two way audio and videoconferencing, and one way vital data telemetry from an ambulance to a L1TC facility node.

LL-SYS-002 Each end of the videoconference shall provide a status window indicating the identity of the remote node.

2.5.4.2.2 Prerequisite Conditions

Hardware and software preparation is complete.

2.5.4.2.3 Test Inputs

None.

2.5.4.2.4 Test Results Evaluation

Test results will comply fully with referenced requirements.
(Note: One way vital data telemetry is tested in LL-SYST-3.)

2.5.4.2.5 Test Procedure

1) At the Ambulance:
   a) Activate the system by pressing the button labeled "Power On".
   b) Initiate the conference.
   c) Verify the remote node identity is displayed in the status bar.
   d) Verify audio connectivity to the L1TC facility.
   e) Verify video connectivity to the L1TC facility.

2) At the L1TC facility:
   a) Acknowledge the conference.
   b) Verify the remote node identity is displayed in the status bar.
   c) Verify audio connectivity to the Ambulance.
   d) Verify video connectivity to the Ambulance.

2.5.4.2.6 Assumptions and Constraints

None.

2.5.4.2.7 Test Results

Yes	No	
☒	☐	Does the LifeLink System provide two way audio and video communications?
☒	☐	Does the system display status message indicating the remote node?

☒ **PASS** ☐ **FAIL** **SwRI:** E Lindfield **Date:** 2/28/01

2.5.4.3 LL-SYST-3

This test verifies the vital data telemetry of the system.

2.5.4.3.1 Requirements Addressed

LL-GEN-001 The system shall provide an Ethernet communications network, two way audio and videoconferencing, and one way vital data telemetry from an ambulance to a L1TC facility node.

LL-GEN-005 The system shall support vital data telemetry at a RS-232 serial link with a rate of 19.2 kbps (Propaq EL106 monitor) between the ambulance and L1TC facility involved in the conference simultaneously with a videoconferencing session.

2.5.4.3.2 Prerequisite Conditions

Hardware and software preparation complete.
The TOC SNMP computer may be used in place of the L1TC facility node, since they have functionally the same configuration relative to this test.
Vital data telemetry equipment is connected at both the ambulance and the L1TC facility node or TOC SNMP computer node. (Note: Vital data telemetry equipment is not provided by the LifeLink system.)

2.5.4.3.3 Test Inputs

None.

2.5.4.3.4 Test Results Evaluation

Test results will comply fully with referenced requirements.

2.5.4.3.5 Test Procedure

1) At the Ambulance:
   a) Verify that the LifeLink application to 19.2 kbps for vital data transfer.
   b) Activate the system and initiate the conference.

2) At the L1TC facility:
   a) Verify that the LifeLink application is set to 19.2 kbps for vital data transfer.
   b) Acknowledge the conference.

3) Verify vital data connectivity with the ProPaq unit by the following:
   a) Connect the ProPaq vital data equipment to each end of the system.
   b) Activate the ProPaq vital data equipment at each end.
   c) Simulate patient vitals on the ProPaq in the ambulance.
   d) Verify that the L1TC facility Protocol Systems Acuity equipment displays the received vital data.
   e) Verify that the conference is unaffected by the transfer.

2.5.4.3.6 Assumptions and Constraints

None.

2.5.4.3.7 Test Results

Yes	No	
☒	☐	Does the vital data transfer work with the Propaq 106EL unit?
☒	☐	Does the vital data transfer using the Propaq monitor occur simultaneously with video and audio?

☒ **PASS** ☐ **FAIL** **SwRI:** _____ **Date:** 2/28/01

2.5.4.4 LL-SYST-4

This test verifies the operation of the system.

2.5.4.4.1 Requirements Addressed

LL-SYS-004 In the event of a temporary loss of communications, the system shall present a "frozen" image of the last good video presented to viewers which will prevail until the transient blockage is removed.

LL-SYS-009 If an ambulance initiates a conference while out of range of the radio communications network, the conference will automatically establish when the ambulance enters radio contact.

LL-SYS-010 If an ambulance drives out of radio contact during a conference and re-enters radio contact within the timeout period, the conference will resume without ambulance system operator intervention.

LL-SYS-011 If an ambulance drives out of radio contact during a conference and remains without radio contact for a time exceeding the timeout period, the conference will terminate without ambulance system operator intervention.

2.5.4.4.2 Prerequisite Conditions

Hardware and software preparation is complete.
The TOC SNMP computer may be used in place of the L1TC facility node since they have functionally the same configuration relative to this test.

2.5.4.4.3 Test Inputs

None.

2.5.4.4.4 Test Results Evaluation

The system should gracefully handle ambulance movement into and out of radio coverage.

2.5.4.4.5 Test Procedure

1) Verify the ability of the system to tolerate movement in and out of system radio coverage by the following:
   a) Position the ambulance outside of the radio coverage of the system.
   b) Verify the Link indicator indicates no link.
   c) Initiate a conference from the ambulance to the L1TC facility.
   d) Verify the system provides feedback that the ambulance is not in range.
   e) Verify the system displays a message offering the option to cancel the connection request.
   f) Drive into range of the system.
   g) Verify the Link indicator indicates a link.
   h) Verify the conference establishes without additional action in the ambulance.
   i) Acknowledge the conference at the L1TC facility node.

j) Drive out of range of the system.
k) Re-enter range of the system with 5 minutes.
l) Verify the conference re-establishes without additional action in the ambulance.
m) Drive out of range of the system.
n) Wait for approximately 5 minutes.
o) Verify the conference automatically terminates.

2.5.4.4.6 Assumptions and Constraints

None.

2.5.4.4.7 Test Results

Yes	No	
☒	☐	Does the LifeLink System maintain a still image during temporary outages?
☒	☐	Does the LifeLink System complete a previously initiated conference upon entering radio range?
☒	☐	Does the LifeLink System resume a conference without ambulance system operator intervention if the link is reestablished within the timeout period?
☒	☐	Does the LifeLink System terminate a conference if the ambulance does not have a radio link for longer than the timeout period?

☒ **PASS** ☐ **FAIL** **SwRI:** [signature] **Date:** 2/28/01

2.5.4.5 LL-SYST-5

This test verifies the call-waiting/busy-signal of the system.

2.5.4.5.1 Requirements Addressed

LL-GEN-002 One controlling L1TC facility node can conference with one ambulance at a time.

LL-SYS-012 If a second ambulance attempts to initiate a videoconference with a L1TC facility node which is already in a conference session, the system will notify both the L1TC facility and the second ambulance. The second ambulance will continue to attempt connection, and a new videoconference session will start when the L1TC facility terminates the existing videoconference.

2.5.4.5.2 Prerequisite Conditions

Hardware and software preparation complete.

2.5.4.5.3 Test Inputs

None.

2.5.4.5.4 Test Results Evaluation

The system should gracefully handle requests from more than one ambulance to participate in a conference.

2.5.4.5.5 Test Procedure

Verify the ability of the system to indicate the unavailability of a node due to a prior connection by the following:

a) Position the ambulance within the radio coverage of the system.
b) Verify the Link indicator indicates a link.
c) Initiate a conference between the TOC node and the L1TC facility.
d) Attempt to initiate a conference between the ambulance and the L1TC facility.
e) Verify the display of a message indicating a conference is already in progress in the ambulance.
f) Verify the display of a message indicating an attempted connection by the ambulance.
g) Terminate the existing TOC to L1TC facility conference.
h) Verify the automatic completion of the ambulance initiated conference.

2.5.4.5.6 Assumptions and Constraints

None.

2.5.4.5.7 Test Results

Yes	No	
☒	☐	Does the ambulance display a message indicating a conference is already in progress?
☒	☐	Does the L1TC facility display a message an attempted connection by the ambulance?
☒	☐	Does the new conference automatically complete upon termination of the existing conference?

☒ **PASS** ☐ **FAIL**

SwRI: Ed Kulp **Date:** 2/28/01

TxDOT: N/A **Date:**

BP 2/28/01

2.5.4.6 LL-SYST-6

This test verifies the call-transfer/call-consult/call hospital-hospital functions of the system.

2.5.4.6.1 Requirements Addressed

LL-GEN-003	A full-duplex videoconferencing session with an ambulance may be transferred to another L1TC facility.
LL-GEN-006	Additional L1TC facility nodes may consult in a conference where the controlling L1TC facility node directs the consult node to receive the audio and video from the ambulance.
LL-GEN-007 (New Requirement)	L1TC facility nodes may participate in a hospital node-to-hospital node video/audio conference where another L1TC facility node initiates the conference, the hospital-hospital conference being terminable by either L1TC node.

2.5.4.6.2 Prerequisite Conditions

Hardware and software preparation complete.

2.5.4.6.3 Test Inputs

None.

2.5.4.6.4 Test Results Evaluation

At the discretion of the controlling L1TC facility node, the conference should be transferable to a different L1TC facility node.

2.5.4.6.5 Test Procedure

1) At the Ambulance:
   a) Activate the system and initiate the conference.

2) At the L1TC facility:
   a) Acknowledge the conference.

3) Verify the ability to transfer a call by the following at the controlling L1TC facility node:
   a) Initiate a call transfer by pressing one (1) button marked "Call Transfer" (F5).
   b) Select a L1TC facility node by entering the two (2) digit code on the keyboard or selecting the default node (no buttons pressed).
   c) Confirm the selection by pressing one (1) button marked "Enter".
   d) Verify the connection is no longer displayed on the original controlling node.
   e) Verify the connection exists on the new controlling node.
   f) Verify no intervention was required by the ambulance system operator.

4) Verify the ability to consult a call by the following at the controlling L1TC facility node:
   a) Initiate a consulting node by pressing one (1) key marked "Add Consult" (F6).
   b) Select a L1TC facility node by entering the two (2) digit code on the keyboard or selecting the default node (no buttons pressed).
   c) Confirm the selection by pressing one (1) button marked "Enter".
   d) Verify the consulting connection is successfully completed.
   e) Terminate the conference

5) Verify the ability to establish a hospital-to-hospital conference.
   a) Initiate a hospital-to-hospital conference by pressing one (1) key marked "F7".
   b) Select a L1TC facility node by entering the two (2) digit code on the keyboard or selecting the default node (no buttons pressed).
   c) Confirm the selection by pressing one (1) button marked "Enter".
   d) Verify the connection successfully completed.
   e) Terminate the conference

Assumptions and Constraints
None.

Test Results

Yes	No	
☒	☐	Does the conference successfully transfer to a new control node?
☒	☐	Does the conference successfully consult to an additional node?
☒	☐	Does the hospital-hospital conference successfully complete?

☒ **PASS** ☐ **FAIL** **SwRI:** _____ **Date:** 2/28/01

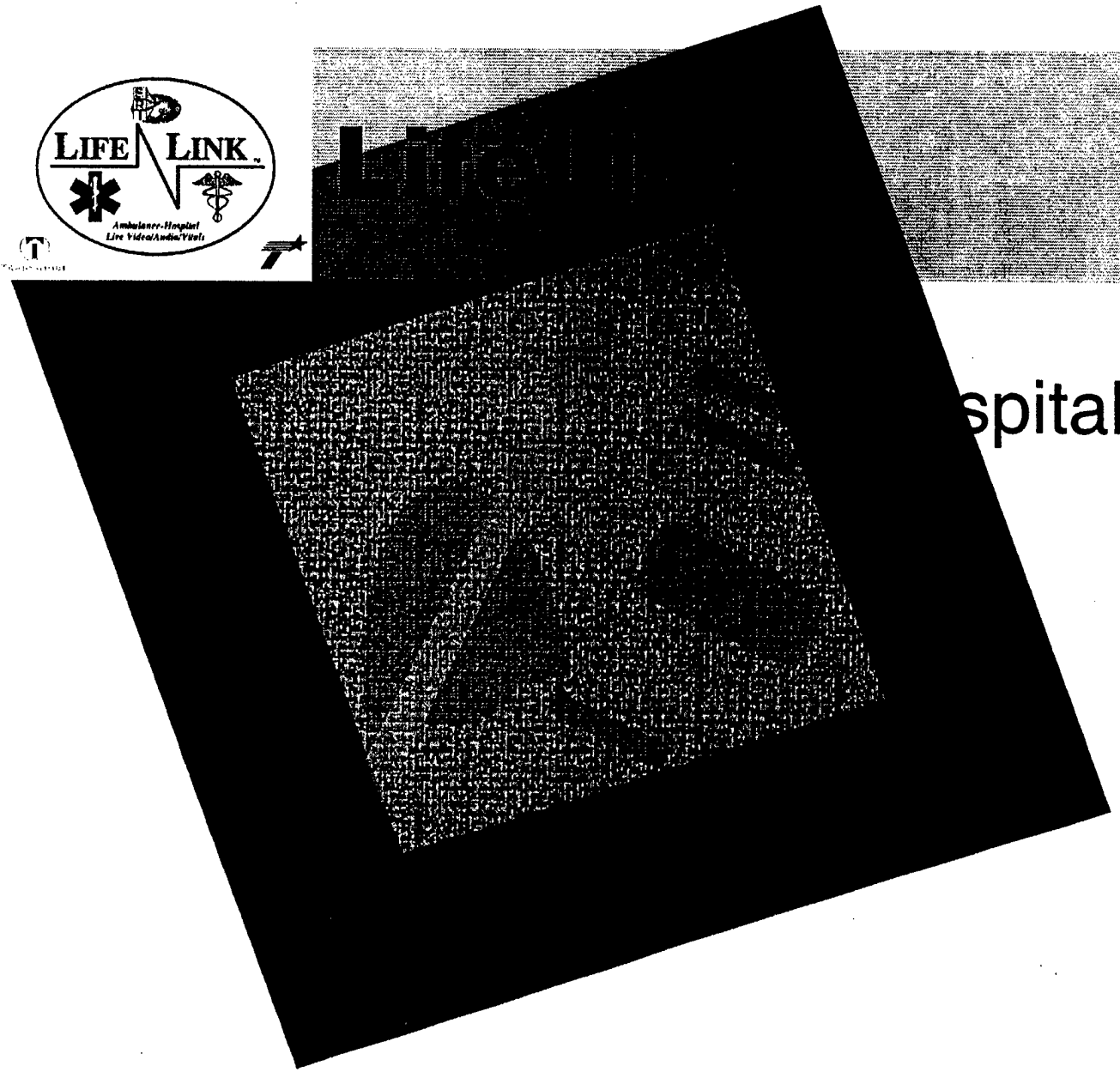
6) REQUIREMENTS TRACEABILITY

Requirement Number	Requirement	Test Case(s)	Verification Method
LL-GEN-001	The system shall provide an Ethernet communications network, two way audio and videoconferencing, and one way vital data telemetry from an ambulance to a L1TC facility node.	LL-SYST-2 LL-SYST-3	Demonstration Inspection
LL-GEN-002	One controlling L1TC facility node can conference with one ambulance at a time.	LL-SYST-6	Demonstration Inspection
LL-GEN-003	A full-duplex videoconferencing session with an ambulance may be transferred to another L1TC facility.	LL-HOSP-2 LL-SYST-6	Demonstration Inspection
LL-GEN-005	The system shall support vital data telemetry at a RS-232 serial link with a rate of up to 38.4 kbps between the ambulance and L1TC facility involved in the conference simultaneously with a videoconferencing session.	LL-SYST-3	Demonstration Inspection
LL-GEN-006	Additional L1TC facility nodes may consult in a conference where the controlling L1TC facility node directs the consult node to receive the audio and video from the ambulance.	LL-SYST-6	Demonstration
LL-GEN-007 (New Requirement)	L1TC facility nodes may participate in a hospital node-to-hospital node video/audio conference where another L1TC facility node initiates the conference, the hospital-hospital conference being terminable by either L1TC node.	LL-SYST-7	Demonstration
LL-SYS-001	Each end of the videoconference shall provide a full-screen view of the received video with a smaller view containing the local image that is being transmitted.	LL-SYST-1	Demonstration Inspection

Requirement Number	Requirement	Test Case(s)	Verification Method
LL-SYS-002	Each end of the videoconference shall provide a status window indicating the identity of the remote node.	LL-SYST-2	Demonstration Inspection
LL-SYS-003	The computer at each end of the videoconference shall be configured to perform automatic operating system startup and application startup.	LL-SYST-1	Demonstration Inspection
LL-SYS-004	In the event of a temporary loss of communications, the system shall present a "frozen" image of the last good video presented to viewers which will prevail until the transient blockage is removed.	LL-SYST-4	Demonstration
LL-SYS-006	The system shall provide voice contact between the controlling physician and the ambulance LifeLink system operator via a single headset provided at each end of the videoconference.	LL-SYST-1	Demonstration Inspection
LL-SYS-008	The videoconference shall provide: A minimum resolution of CIF (352x240 pixels), Scalability to full screen, Display of the transmitted image, Operation within the radio bandwidth.	LL-SYST-1	Demonstration Inspection
LL-SYS-009	If an ambulance initiates a conference while out of range of the radio communications network, the conference will automatically establish when the ambulance enters radio contact.	LL-SYST-4	Demonstration
LL-SYS-010	If an ambulance drives out of radio contact during a conference and re-enters radio contact within the timeout period, the conference will resume without ambulance system operator intervention.	LL-SYST-4	Demonstration

Requirement Number	Requirement	Test Case(s)	Verification Method
LL-SYS-011	If an ambulance drives out of radio contact during a conference and remains without radio contact for a time exceeding the timeout period, the conference will terminate without ambulance system operator intervention.	LL-SYST-4	Demonstration
LL-SYS-012	If a second ambulance attempts to initiate a videoconference with a L1TC facility node which is already in a conference session, the system will notify both the L1TC facility and the second ambulance. The second ambulance will continue to attempt connection, and a new videoconference session will start when the L1TC facility terminates the existing videoconference.	LL-SYST-5	Demonstration
LL-HOS-001	The L1TC facility subsystem shall include one PC.	LL-HOSP-1	Demonstration Inspection
LL-HOS-002	The L1TC facility PC shall provide necessary connections and ports for connection to fixed location vital statistics monitoring equipment.	LL-HOSP-1	Demonstration Inspection
LL-HOS-003	The L1TC facility PC shall support 10BaseT Ethernet connectivity.	LL-HOSP-1	Demonstration Inspection
LL-HOS-004	The L1TC facility PC shall provide unobstructed access to other L1TC facility equipment or walkways.	LL-HOSP-3	Demonstration Inspection
LL-HOS-005	User interface to the LifeLink L1TC facility computer shall limit (to a practical extent) the actions required to answer, transfer, or terminate a videoconferencing session.	LL-HOSP-2	Demonstration

APPENDIX B. LifeLink™ Training Presentation



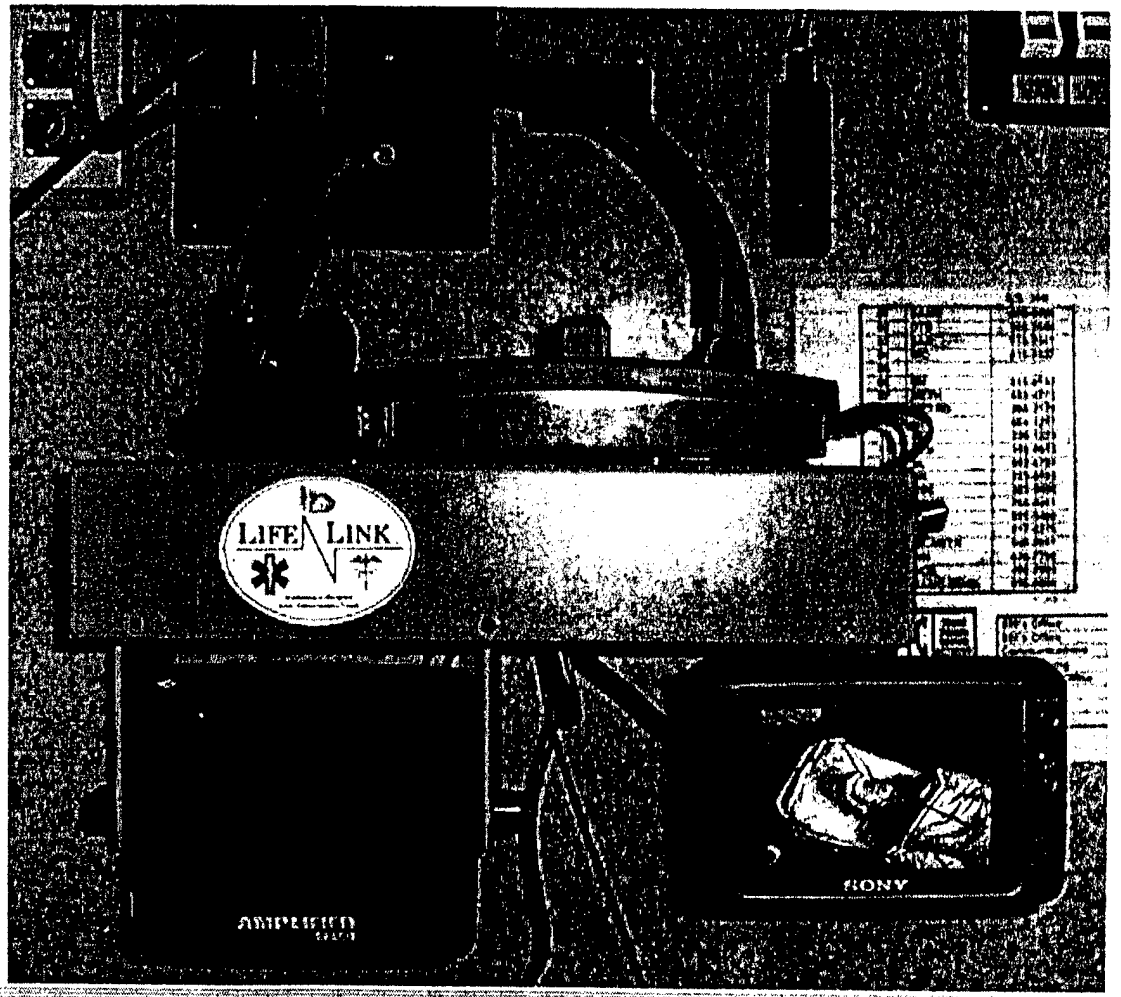
spital Training

Overview

- Ambulance
  - Components
- Hospital
  - Components
  - Interaction

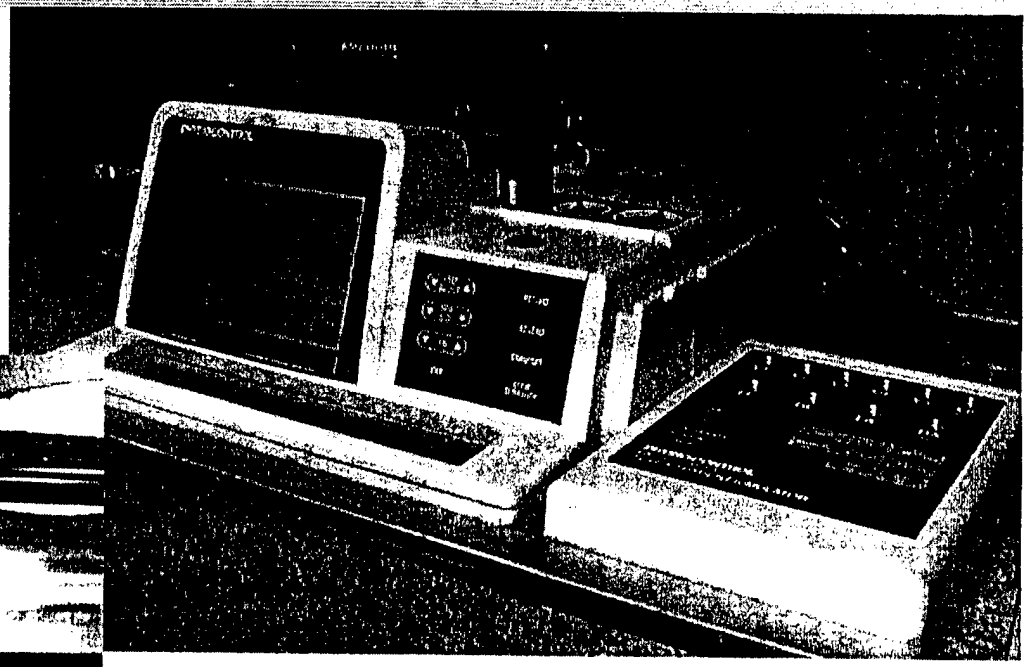
Ambulance Components: MAIN DISPLAY & CAMERA

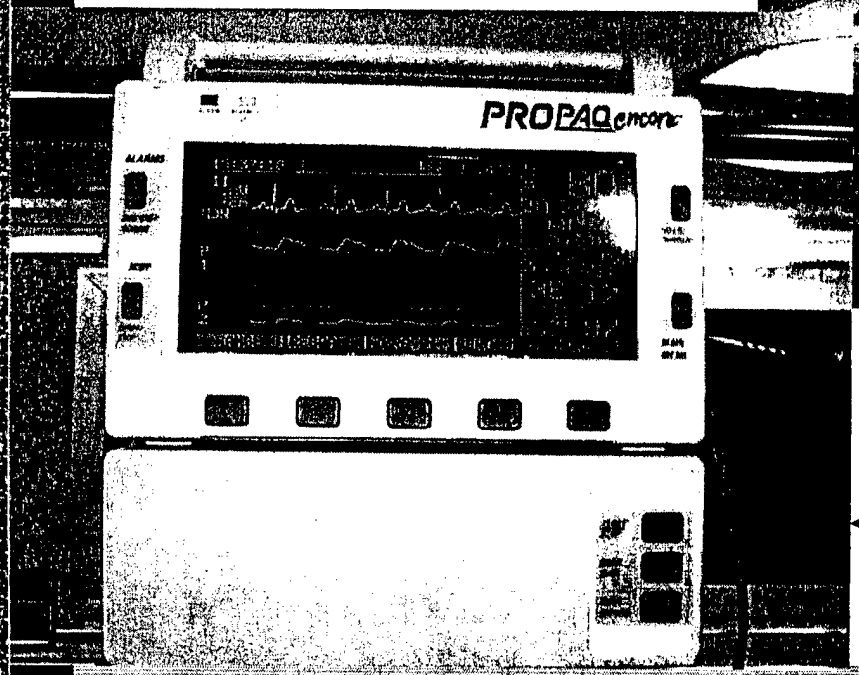
Ambulance Components: SIGNAL DISTRIBUTION



Ambulance Components: VITAL DATA EQUIPMENT

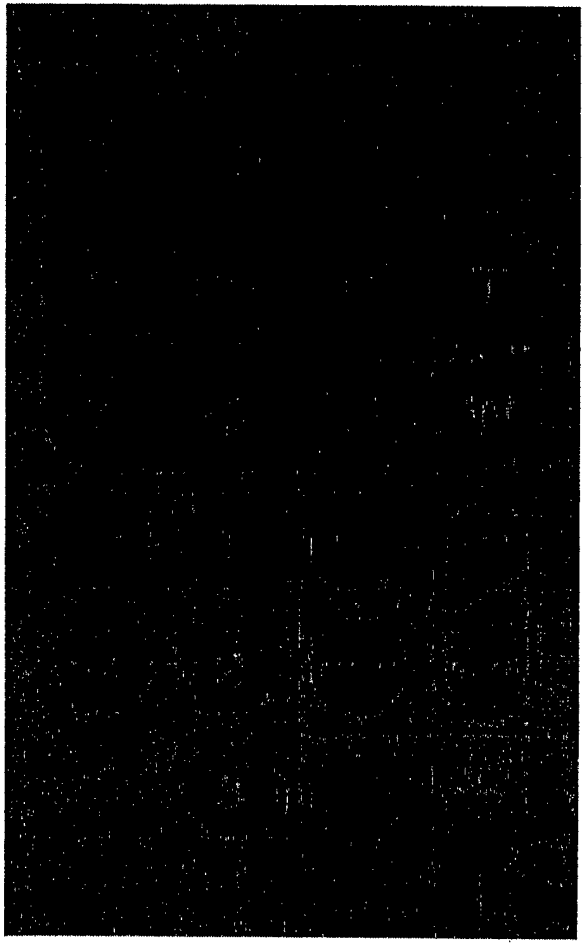
LIFEPAK11 →



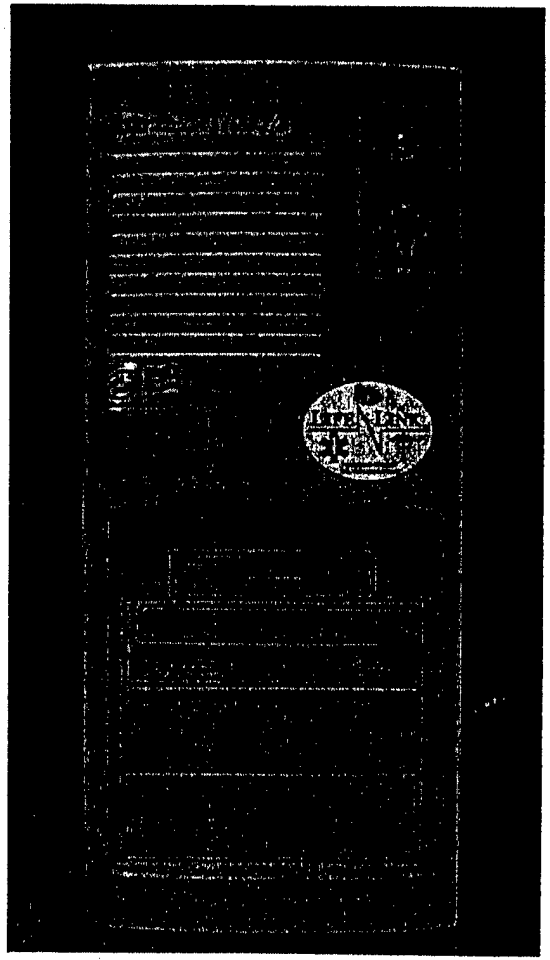


← PROPAQ ENCORE

Ambulance Components: CAMERA CONTROL

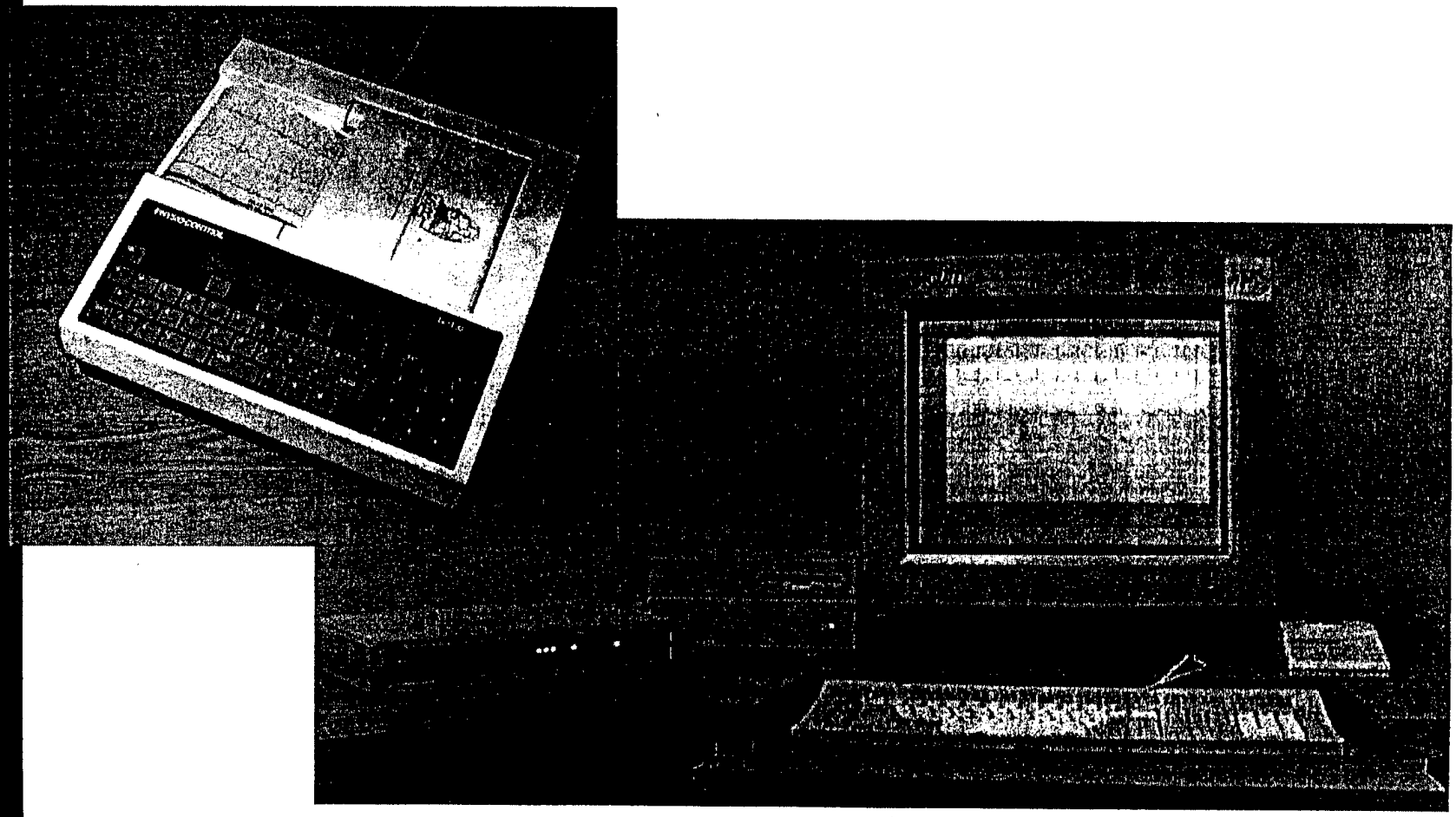


Hospital Components: PC Tower

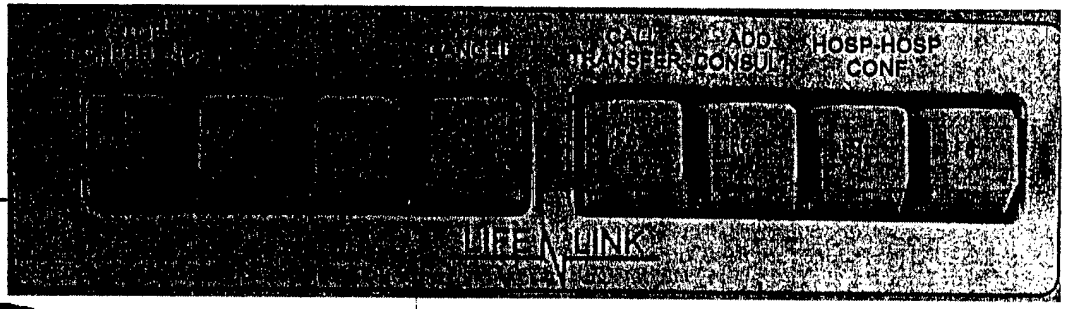


Hospital Components: DISPLAY & CAMERA

Hospital Components: VITAL DATA EQUIPMENT



Hospital Interaction: STARTUP



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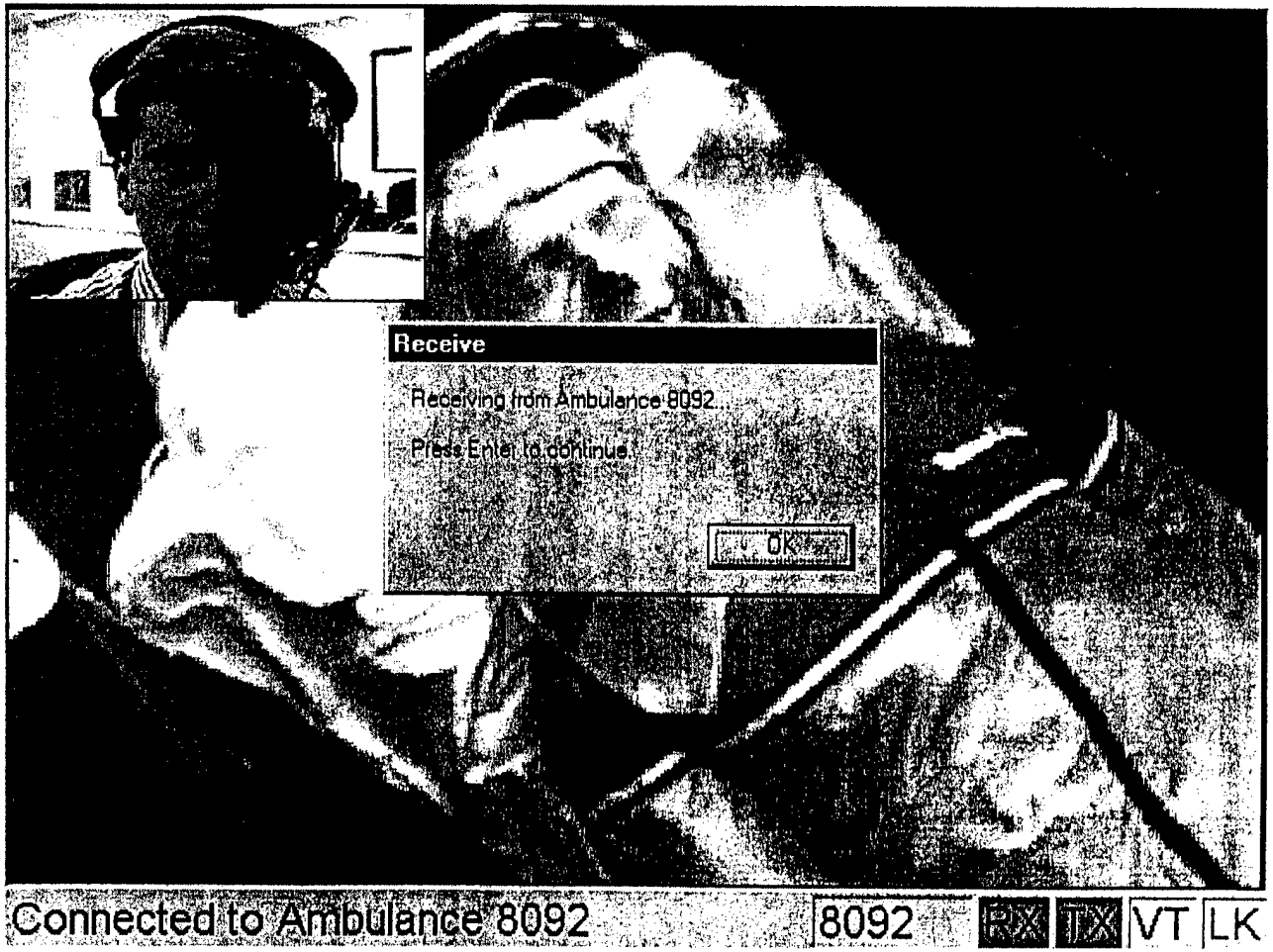
Ambulance-Hospital
Live Video/Audio/Vitals

TRANSGUIDE

Ready RX TX VT LK

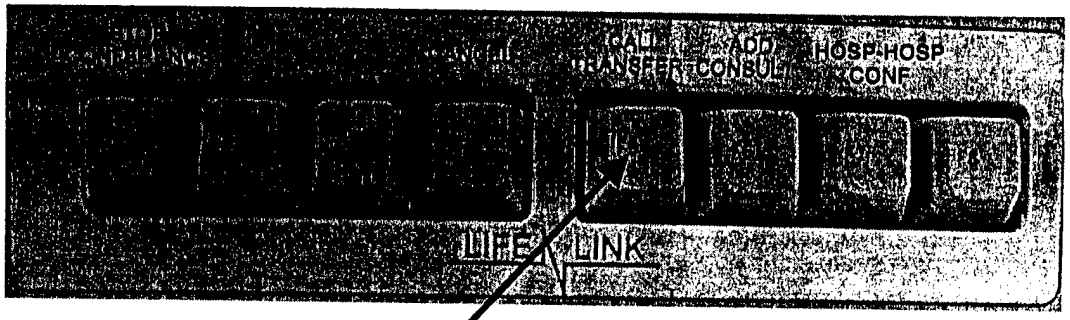
Hospital Interaction: STATUS INDICATORS

Hospital Interaction: CONFERENCE INITIATION

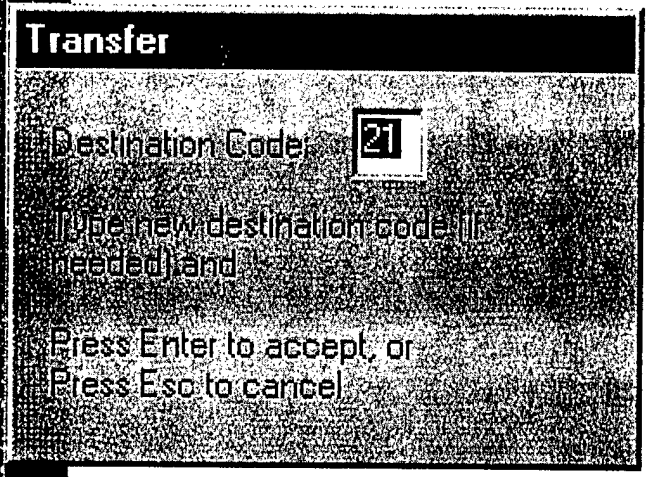


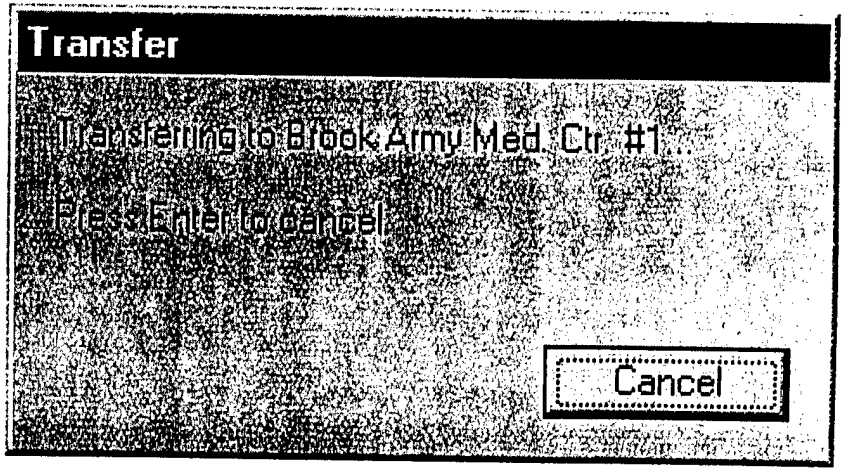
Hospital Interaction: CALL WAITING

Hospital Interaction: CALL TRANSFER (F5)

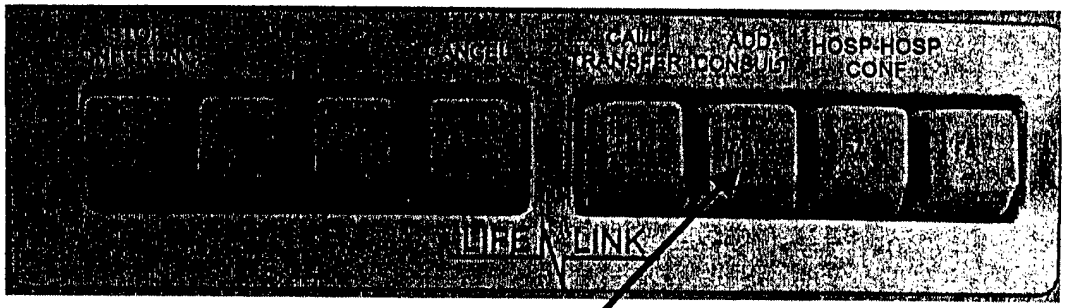


F5

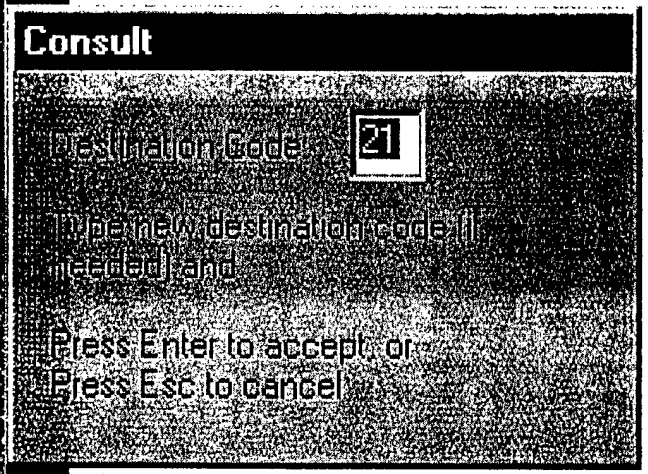


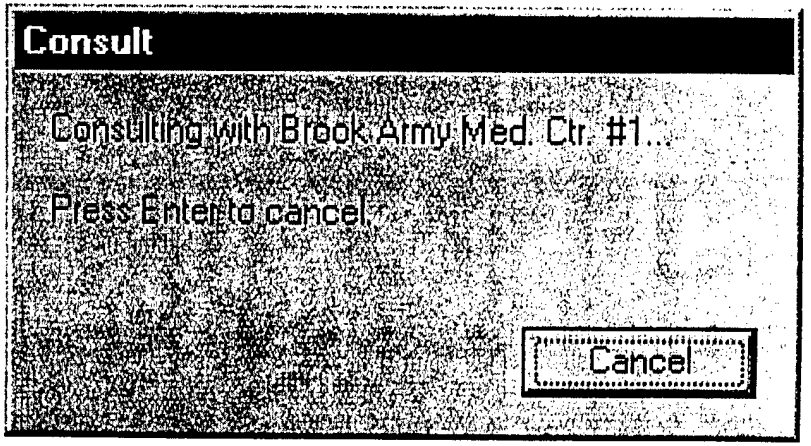


Hospital Interaction: CALL CONSULT (F6)

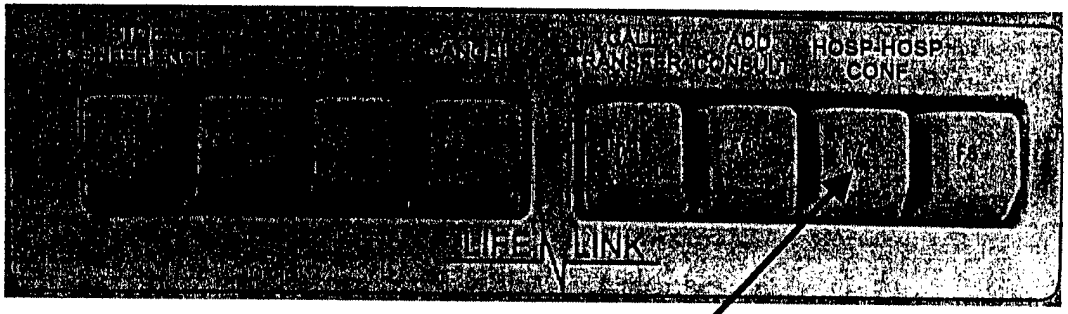


F6

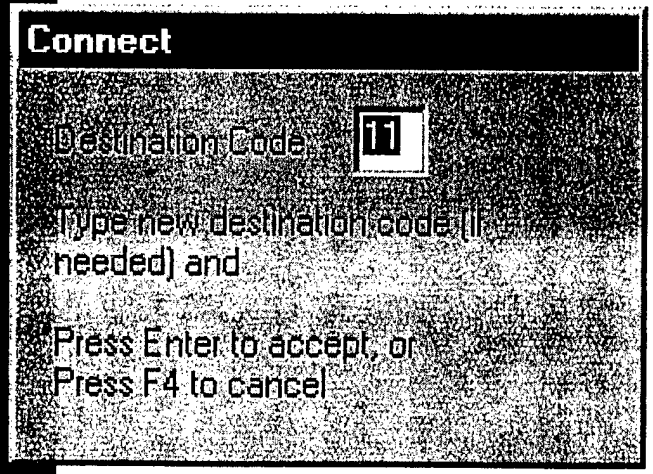


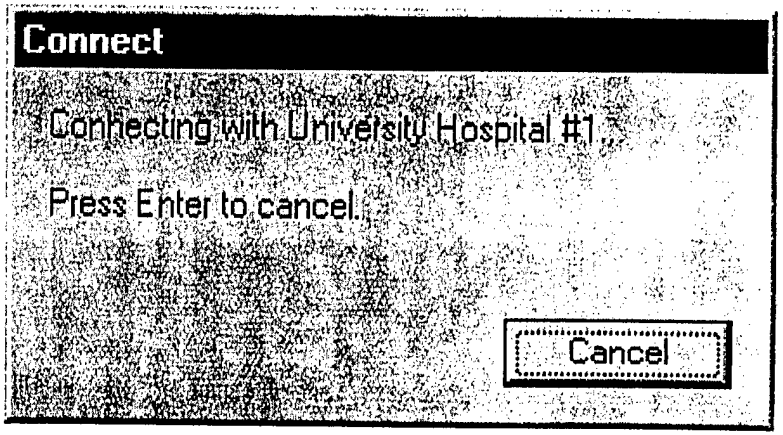


Hospital Interaction: Call Hospital Terminal (F7)



F7

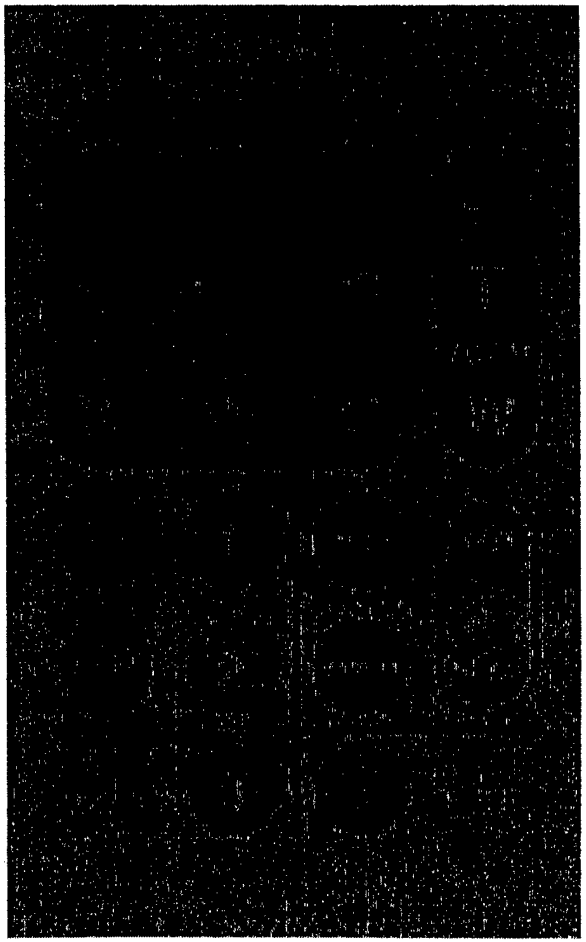




Hospital Interaction: BUSY NOTIFICATION

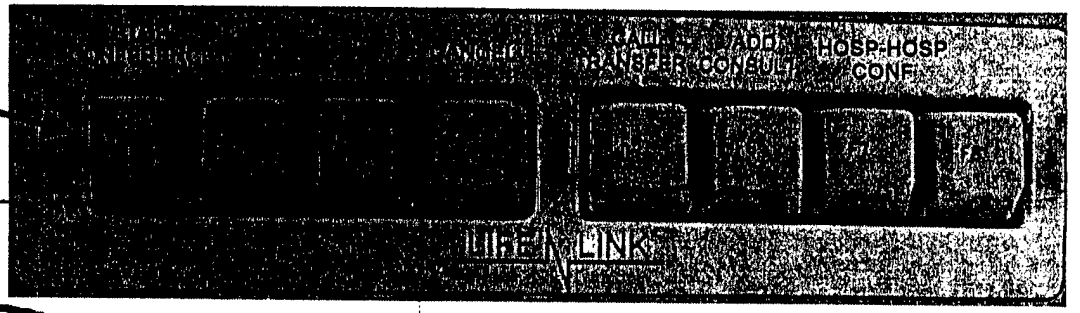
Hospital Terminal -to- Hospital Terminal (F7)

Hospital Interaction: CAMERA CONTROL



Hospital Interaction: TERMINATION/SHUTDOWN

F1



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Ambulance-Hospital
Live Video/Audio/Vitals

TRANSGUIDE

Ready RX TX VT LK

APPENDIX C. LifeLink™ Hospital Terminal Abbreviated Operating Instructions

Controlled Document # 3912-0018

LifeLink Hospital Terminal Operation

Active Keyboard Keys: ENTER, F1, F4, F5, F6, F7, Numbers

- **ACCEPT** incoming call and stop chimes - **<ENTER>**

- **TERMINATE** current call - **<F1>**

- **TRANSFER** call to another hospital terminal and terminate call at this terminal:
  1. **<F5>**
  2. **<2-DIGIT CODE>** for target terminal
  3. **<ENTER>** to initiate the transfer
  - *CANCEL* transfer before initiation- **<F4>**

- **CONSULT** (share incoming video/audio with another hospital terminal:
  1. **<F6>**
  2. **<2-DIGIT CODE>** for target terminal
  3. **<ENTER>** to initiate the consult
  - *CANCEL* consult before initiation- **<F4>**

- **CALL** another hospital terminal:
  1. **<F7>**
  2. **<2-DIGIT CODE>** for target terminal
  3. **<ENTER>**
  - *CANCEL* call before initiation- **<F4>**

2-DIGIT CODES for HOSPITAL TERMINALS:

01 - BAMC ED
06 - University Hospital ER

3/14/01 3/7/01

APPENDIX D. LifeLink™ Hospital Terminal User's Manual

Controlled Document # 3912-0015

LifeLink™ Hospital Node User's Manual

Prepared By:

SOUTHWEST RESEARCH INSTITUTE
6220 Culebra Rd.
San Antonio, Texas 78238

March 19, 2001

In Response To:

Basic Contract Number: V674P-2995
Order Number: 674-W00138

Key Personnel:

Mr. Brian Robey
Southwest Research Institute
Project Manager
210-522-5115

Mr. E. Sterling Kinkler, Jr. PE
Southwest Research Institute
Principal Engineer
210-522-3478

The views, opinions, and/or findings contained in this report are those of the author's and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

NOTICE and ERRATA
March 7, 2001

This document is a reproduction of Chapter 3 of the System Users Manual, version 1.1, August, 1998 for Emergency Medical Services: LifeLink™, Model Deployment Initiative, provided by the Texas Department of Transportation. The following items describe recent updates to the user's manual affecting operation of the hospital node.

1. Figure 18 shows a connection between a hospital node and a telephone company network. The connection between Brooke Army Medical Center and the LifeLink™ network uses dedicated fiber optic connections and associated communications equipment rather than telephone company connections as shown in Figure 18.

2. Add:

3.2.11 Hospital-to-Hospital Conference

With the LifeLink™ Hospital node in the Ready state, initiate the 'conference between hospital nodes' process by pressing the "F7" key on the keyboard. The system then displays the *Connect* dialog as shown in Figure 30A. The user can accept the default hospital destination code by pressing the "ENTER" key on the keyboard or use the keyboard to enter a new 2-digit hospital destination code followed by the "ENTER" key. Table 2A provides a listing of currently supported destination codes. Pressing "F4" cancels the conference initialization process and returns the system back to the Ready screen.

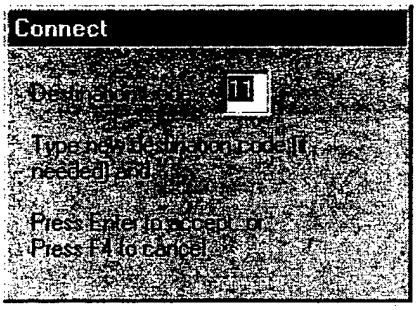

Figure 30A: Connect Dialog

Table 2A: Destination Codes

DESTINATION CODE	DESTINATION NAME AND NODE
01	BAMC Node
02-05	Reserved
06	**University Hospital Node**
07-18	Reserved
19	WHMC Node – Future
20-31	Reserved
32-39	University Hospital Node #2-9 – Future
40-41	Reserved
42-49	BAMC Node #2-9 - Future
50-51	Reserved
52-59	WHMC Node #2-9 – Future
60-61	Reserved
62-69	Hospital 4 Node #2-9 – Future
70-98	Reserved

After pressing the "ENTER" key in the *Connect* dialog, the system attempts to call the target hospital destination. The *Connect Wait* dialog shown in Figure 30B identifies the destination hospital and persists until the call successfully completes. During the call attempt, pressing the "ENTER" key terminates the connection attempt.

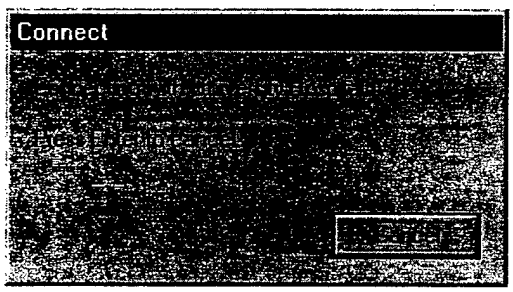

Figure 30B: Connect Wait Dialog

The call may be canceled any time during the connection attempt by pressing the F4 button prior to call completion. An active conference automatically initiates when the call completes. Figure 30C shows an example of the video presented on the display. Audio from the destination hospital node automatically plays out of the headset's speaker. Speaking into the headset's microphone sends audio to the destination hospital node.

Figure 30C: Ambulance Conference Screen

3.2.12 Busy Notification

If the selected destination hospital node is already conferencing with an ambulance or other hospital node, the system displays a message in the status bar Message Area similar to "Remote already connected to 8092". The call automatically completes, unless canceled at the subject hospital node, as soon as the destination hospital node terminates the prior conference.

Chapter 3

Hospital Operation

Emergency Medical Services: LifeLink Model Deployment Initiative System Users Manual

Version 1.1

SwRI Project No. 10-8684

P.O. No. 7-70030

Req. No. 60115-7-70030

August, 1998

Prepared For:

Texas Department of Transportation

TransGuide

3500 NW Loop 410

San Antonio, Texas 78229

Prepared by:

Southwest Research Institute

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San Antonio, Texas 78228

3. Hospital Operation

The LifeLink system provides a hospital with a communications link to LifeLink-equipped mobile ambulances on or near portions of the San Antonio freeway system. A LifeLink hospital node offers two-way data communications from the hospital to medical personnel in an ambulance. Video, audio, and patient monitoring data travel across this communications path between hospital and ambulance.

3.1 Hospital Components

LifeLink hospital equipment provides capture, transmission, and display of video, audio, and patient monitoring data across a wireless Ethernet communications link. Figure 18 provides an overview block diagram of the major LifeLink hospital components. The following subsections provide a brief description of the hospital components grouped by physical location in a LifeLink-equipped hospital. Section 6 of the *LifeLink System Design Document* provides a detailed discussion of the installed equipment.

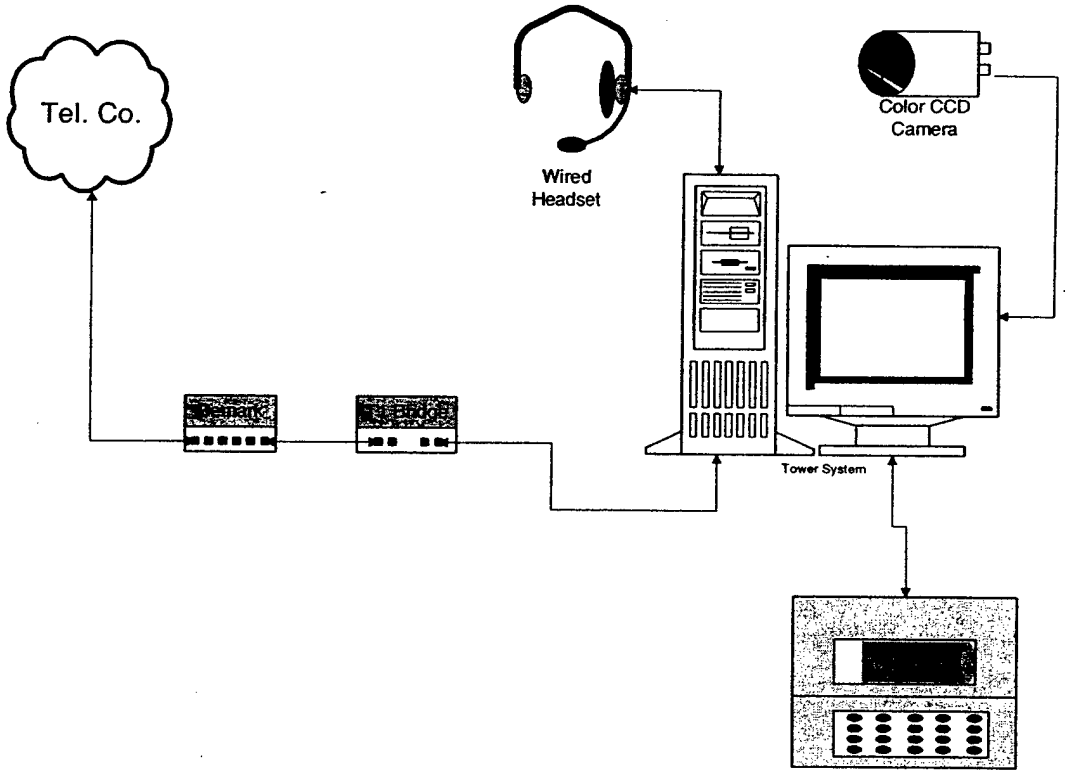

Figure 18: Hospital Components

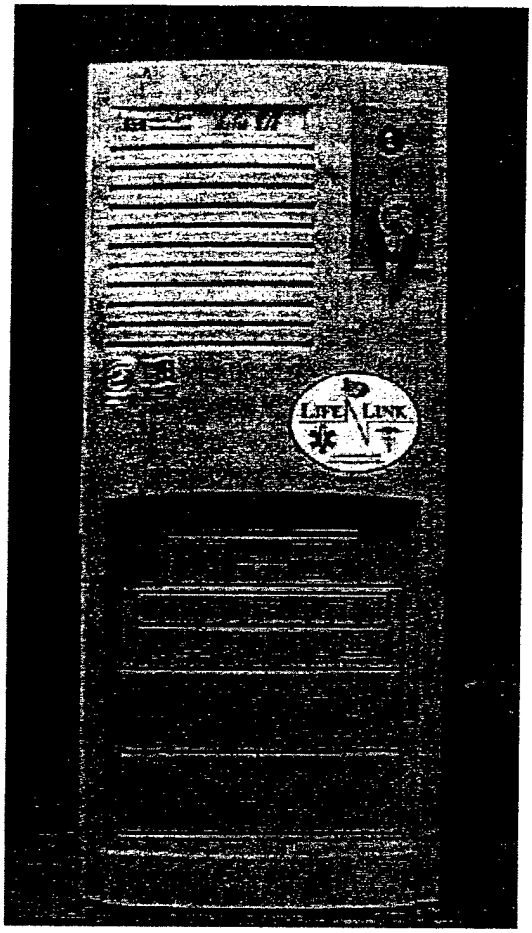

Figure 19: PC Tower

3.1.1 PC Tower

The PC Tower shown in Figure 19 provides several functions for the LifeLink system operator in the hospital. An attached keyboard serves as the main interaction point between the LifeLink system and the hospital operator. (The mouse is not used by the LifeLink system.) Section 3.2 describes the role of the keyboard in the conference. A wired headset connected to the PC Tower provides the primary audio link to the hospital. Section 2.2.4 describes the role of audio in the conference.

Figure 20: Hospital Display and Camera

3.1.2 Hospital Display and Camera

The Hospital Display and Camera shown in Figure 20 serve as the video output and input for the LifeLink system in the hospital. The Hospital Display shows the received image from the ambulance, a smaller local view, and status information. At system power up, the camera defaults to a home position pointing at the upper portion of the chair in front of the Hospital Display with auto focus enabled. This position is intended to provide a facial view of the hospital LifeLink system operator. The camera comes with an infrared remote control that can be used by the system operator to manually position and control the camera, enabling adjustment for different hospital LifeLink system operators. Section 3.2.8 describes the use of the camera remote control and explains the status information presented on the Main Display.

The smaller local view displays the field of view offered by the local camera when the remote control is used to change the view sent to the ambulance. Section 3.2.2 describes the use of the smaller local view.

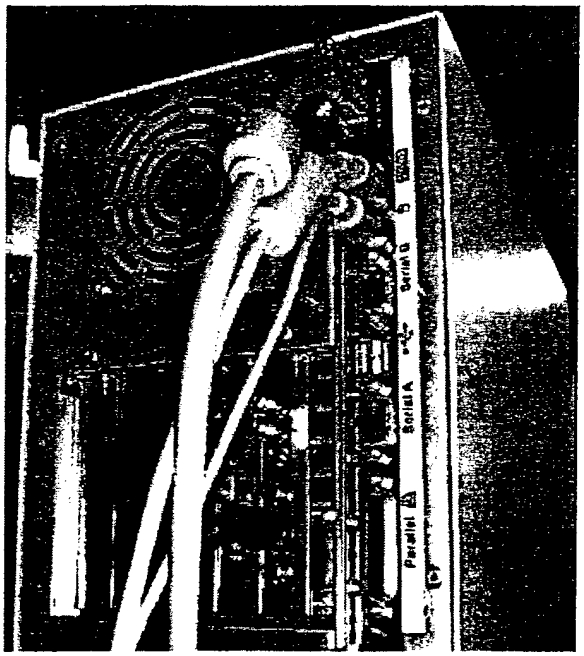

Figure 21: PC Tower Port View

3.1.3 Vital Data Equipment

A serial port on the back of the PC Tower shown in Figure 21 offers the capability to connect a patient monitoring receiving station to the LifeLink system in the hospital for automated reception in the hospital during an active conference. Section 3.2.5 describes the use of a patient monitoring receiving station with the LifeLink system in the hospital.

(NOTE: Only one vital data transfer device may be connected to the hospital node at a time.)

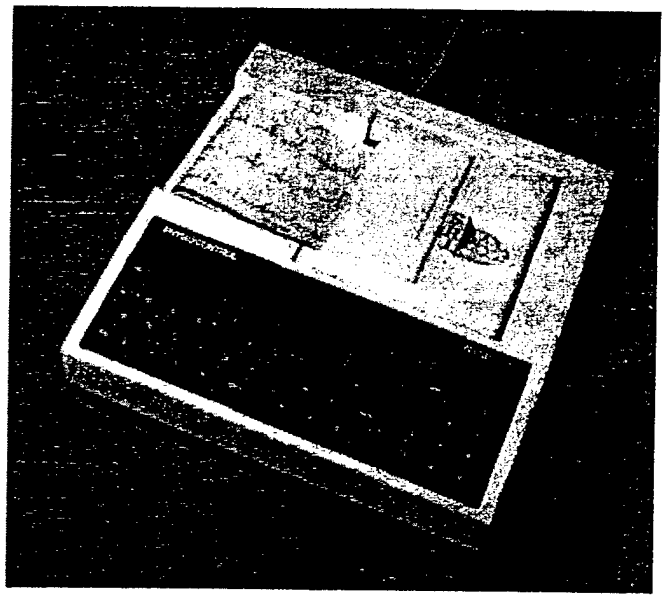

Figure 22: Physio-Control RS-100 Receiving Station

3.1.3.1 Physio-Control RS-100 Receiving Station

The LifeLink system supports Vital Data Transfer with the Physio-Control RS-100 Receiving Station. Figure 22 shows the RS-100 Receiving Station hospital equipment. To connect the RS-100 Receiving Station to the LifeLink system, attach the Physio-Control adapter cable described in Appendix B of the *LifeLink System Design Document* to the DB-9 *SYSTEM* port on the rear of the RS-100 Receiving Station. Connect the other end of the adapter cable to the DB-9 *COM A* port on the rear of the PC Tower.

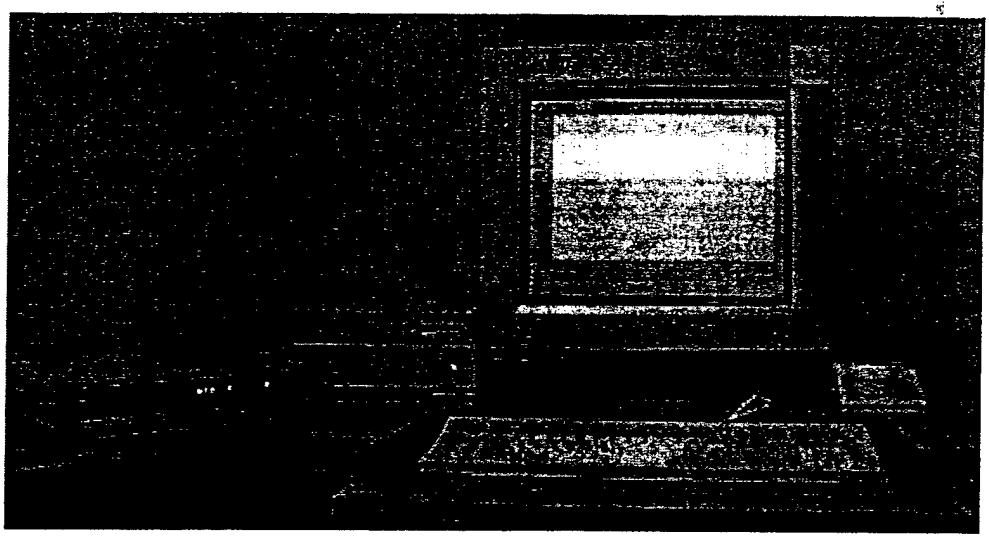

Figure 23: Protocol Systems Acuity Monitoring System

3.1.3.2 Protocol Systems Acuity Monitoring System

The LifeLink system supports Vital Data Transfer with the Protocol Systems Acuity Monitoring System. Figure 23 shows the Protocol Systems Acuity Monitoring System hospital equipment which includes the Acuity Workstation and Remote Annex 2000. Connect the Acuity Workstation to the Remote Annex 2000 according to the Protocol Systems Acuity Monitoring System instructions. To connect the Remote Annex 2000 to the LifeLink system, attach the Protocol Systems adapter cable described in Appendix B of the *LifeLink System Design Document* to the RJ-45 *FULL MODEM CONTROL* terminal server port on the rear of the Remote Annex 2000. Connect the other end of the adapter cable to the DB-9 *COM A* port on the rear of the PC Tower.

3.2 Hospital System Interaction

The LifeLink application is intended to be as easy to use as possible. This is accomplished by minimizing the operations that need to be performed and by minimizing the actions needed to perform a given operation. Most operations will require only one or two keystrokes. Because of the operation-oriented nature of the LifeLink application, this section is organized by operation. The following subsections provide a detailed description of how to use the LifeLink system in the hospital.

3.2.1 Startup

Pressing the power on button on the PC Tower begins the startup procedure for the LifeLink system in the hospital. The boot process, which takes about 90 seconds, completes with system initialization when the System Ready screen shown Figure 24 is displayed on the Hospital Display. At this point, the application is ready for use.

(NOTE: It is intended that the LifeLink hospital node always be active. Therefore, system startup should only be necessary after the initial setup or after system maintenance.)

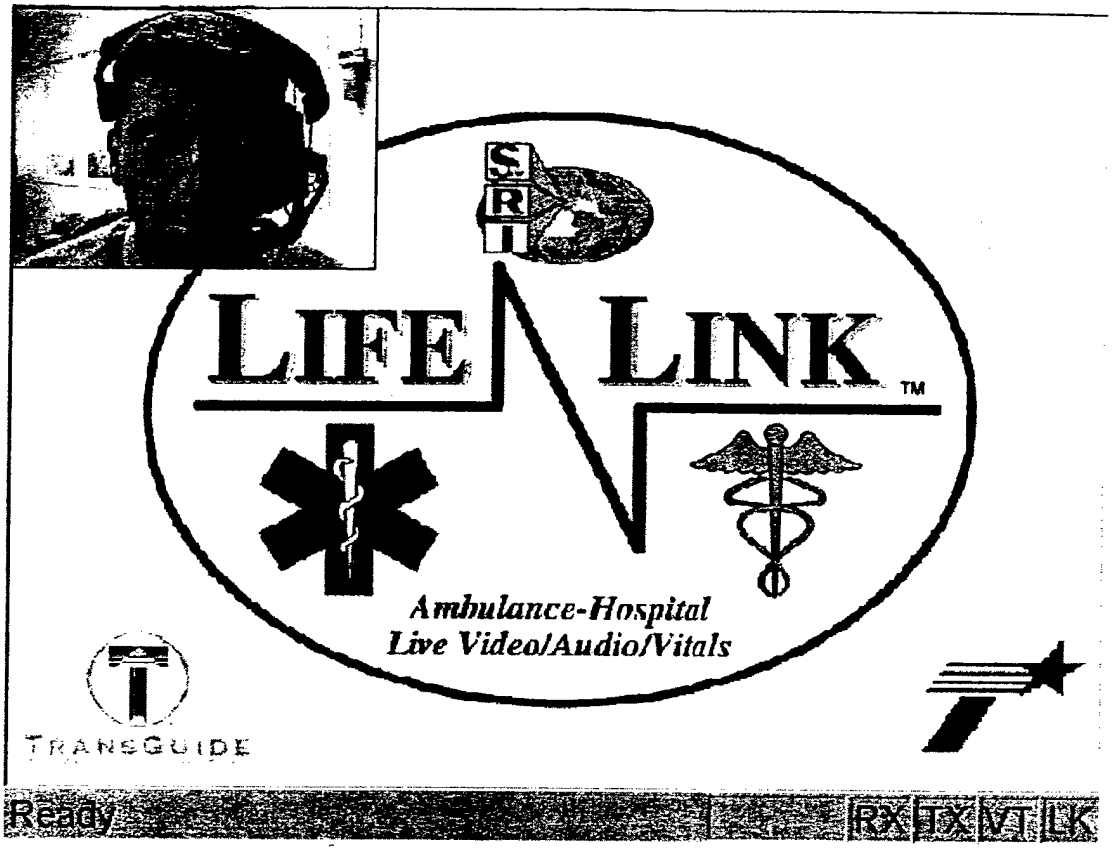

Figure 24: Hospital System Ready Screen

3.2.2 Status Indicators

The top portion of the System Ready screen shown in Figure 24 contains the LifeLink logo. Received video from the ambulance fills this area during an active conference. In the upper left-hand corner, a window shows the status of the local camera's field of view. Since this view is only intended to provide status information, video quality and frame rate received in the ambulance will differ.

The status bar along the bottom of the screen provides system performance feedback. The **Message Area** fills the left most pane of the status bar. The Message Area displays non-alert system status feedback such as "Initialization complete", "Ready", and "Connected to Ambulance 8092". The **Remote Node Indicator** fills the second pane from the left. This pane displays the ambulance identification number given by the San Antonio Fire Department (SAFD) indicating the ambulance receiving the conference. The **Remote Node Indicator** appears blank when a conference is not in progress. The remaining four panes provide general conference performance feedback. Table 1 explains the information they present.

3.2.3 Conference Initiation

When in the LifeLink System Ready state, the hospital node automatically receives ambulance calls and displays the conference, provided any prior call to the hospital node

has terminated. A *Receive Notification* dialog similar to Figure 25 appears indicating the receipt of the conference and identifying the caller's ambulance number. A chime alerts hospital personnel of the incoming call. The chime and *Receive Notification* Dialog persist until the "ENTER" key on the keyboard is pressed. Received video then fills the area previously occupied by the logo on the Hospital Display as shown in Figure 26. Audio from the ambulance automatically plays on the headset's speaker. Simply speaking into the headset's microphone sends audio to the ambulance.

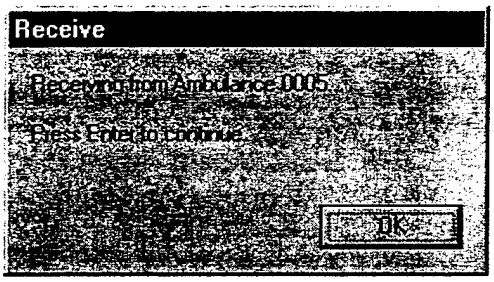

Figure 25: Receive Notification Dialog

Figure 26: Hospital Conference Screen

3.2.4 Call Waiting Notification

If the hospital node is already conferencing with an ambulance when another ambulance places a call to same hospital node, the system displays a message in the status bar Message Area similar to "New Request from ambulance 0002". The call will automatically complete, unless canceled in the ambulance, as soon as the hospital terminates the prior conference. If canceled by the ambulance, a "New Call Request Canceled" message appears in the **Message Area** on the Hospital Display.

3.2.5 Vital Data Transfer

When present, the LifeLink system automatically transfers data communications from patient monitoring equipment to a matched receiving station connected to the primary hospital node in an active conference with the ambulance.

3.2.5.1 Physio-Control RS-100 Receiving Station

To use a Physio-Control RS-100 Receiving Station, connect the RS-100 Receiving Station to the PC Tower as described in Section 3.1.3.1. Begin using the RS-100 Receiving Station as normal. If a Physio-Control Lifepak 11 is properly connected to the ambulance node actively conferencing with the primary hospital node, data communications with the Lifepak 11 occurs without user intervention in the hospital.

3.2.5.2 Protocol Systems Acuity Monitoring System

To use a Protocol Systems Acuity Monitoring System receiving station, simply connect the Acuity Monitoring System to the PC Tower as described in Section 3.1.3.2. Begin using the Acuity Monitoring System as normal. If a Propaq Encore 250EL is properly connected to the ambulance node actively conferencing with the primary hospital node, data communications with the Propaq Encore 250EL occurs without user intervention in the hospital.

3.2.6 Call Transfer

The call transfer functionality of the LifeLink system disconnects an active hospital node from a conference and at the same time routes the call to a different hospital node which automatically accepts the transfer. While in an active conference, pressing the "F5" key on the keyboard initiates a call transfer. The *Call Transfer* dialog, as shown in Figure 27, prompts the speaker for the entry of a destination code from Table 2. After entering the code, pressing "Enter" on the keyboard begins the call transfer process.

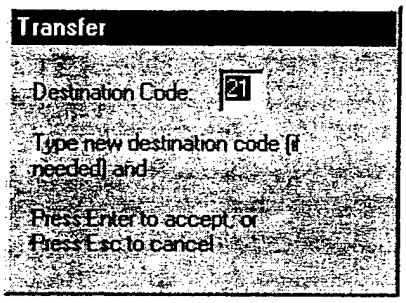

Figure 27: Call Transfer Dialog

Next, a *Call Transfer Wait* dialog, as shown in Figure 28, appears indicating the name of the recipient hospital node. The dialog also provides the opportunity to cancel the transfer by pressing the "Enter" key on the keyboard. Completion of the call transfer requires the ambulance involved in the conference to be within communications range of the LifeLink system. If the ambulance is currently out of the LifeLink communications coverage area, the transfer will automatically complete when communication with the ambulance is restored unless canceled by the initiating hospital node. Once the ambulance receives the call transfer request, the *Call Transfer Wait* Dialog disappears and the initiating hospital node returns to the Hospital System Ready screen shown in Figure 24. The recipient hospital node automatically receives the transferred call and proceeds as described in Section 3.2.3 if a prior conference to that node is not currently in progress. If a prior conference is currently in progress on the recipient hospital node, the ambulance busy notification described in Section 2.2.5 and the hospital call waiting notification described in Section 3.2.4 occur.

(NOTE: Only a primary hospital node can initiate a Call Transfer.)

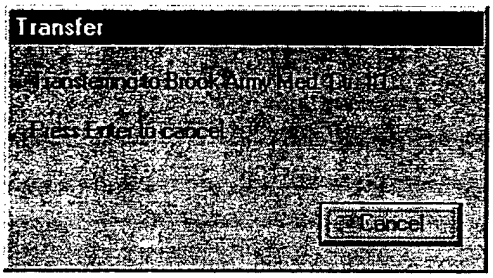

Figure 28: Call Transfer Wait Dialog

3.2.7 Call Consult

The call consult functionality of the LifeLink system shares the audio and video received by a primary hospital node in an active conference with a different hospital node which automatically accepts the consult. A consulting hospital node does not receive patient monitoring data nor does it transmit any data to the ambulance or primary hospital node. Communications from a consulting node to the ambulance or primary hospital node are expected to take place via traditional communications paths (telephones, two-way radios, etc.). While in an active conference, pressing the "F6" key on the keyboard of the primary hospital node initiates a call consult. After pressing "F6", the *Call Consult*

dialog, as shown Figure 29, appears, prompting for a destination code from Table 2. After entering the code, pressing "Enter" on the keyboard begins the call consult process.

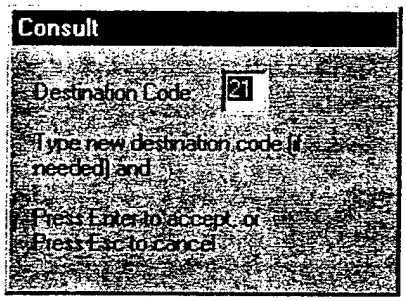

Figure 29: Call Consult Dialog

Next, a *Call Consult Wait* dialog, as shown in Figure 30, appears indicating the name of the recipient hospital node. The dialog also provides the opportunity to cancel the consult by pressing the "Enter" key on the keyboard. Once the recipient hospital node receives the call consult request, the *Call Consult Wait* dialog disappears and the initiating hospital node returns to the existing Hospital Conference screen shown in Figure 26. The recipient hospital node automatically receives the consulted call and proceeds as described in Section 3.2.3 if a prior conference to that node is not currently in progress. If a prior conference is currently in progress on the recipient hospital node, the *Call Consult Wait* dialog remains on the main display of the primary hospital node and a message indicating the busy status of the recipient node displays in the message area of the status bar. The message area of the recipient hospital node displays a message indicating the attempted consult. The *Call Consult Wait* dialog disappears and the consult completes automatically once the recipient hospital node terminates the prior conference unless the primary hospital node cancels the consult first. The consulting hospital node continues to receive audio and video from the ambulance for the duration of the conference unless terminated as described in Section 3.2.9.

(NOTE: Only a primary hospital node can initiate a Call Consult.)

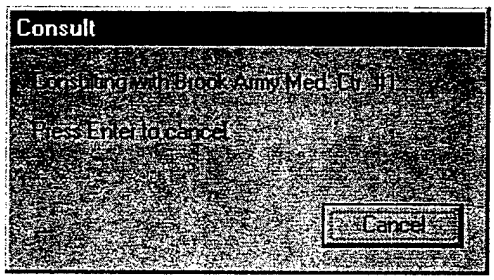

Figure 30: Call Consult Wait Dialog

3.2.8 Camera Control

The infrared remote control shown in Figure 14 offers manual positioning and camera control. Pressing the arrow buttons controls the pan and tilt functionality. Pressing the *HOME* button returns the pan and tilt to the default location. The *T* button stands for

Telephoto and enables zooming in on a specific location. The *W* button stands for *Wide Angle* and enables zooming out on a specific location. The *HOME* button does **not** restore the default zoom. The *Back Light* button toggles the brightness compensation for direct sunlight. For additional information, see the *Sony EVI-G20 Operating Instructions* manual.

(NOTE: At this time, the hospital cannot control the camera in the ambulance.)

3.2.9 Conference Termination

Pressing the "F1" key on the keypad terminates the conference. This results in immediate termination of the conference and the Hospital Display returning to the Hospital System Ready screen. An active conference may be terminated at any time regardless of whether the ambulance is currently within the LifeLink coverage area or not.

*(NOTE: Termination of a conference by the primary hospital node with active consulting nodes does not propagate to the consulting nodes. Consulting node **RX** indicators will simply turn red until the consulting nodes time out and then return to the Hospital System Ready screens.)*

3.2.10 Shutdown

The hospital node is intended to always be active. Consult qualified maintenance personnel if it is necessary to shutdown the hospital node.

APPENDIX E. LifeLink™ Installation Report

Controlled Document # 3912-0014

IMPLEMENTATION OF LIFELINK™ CONNECTIONS AT BROOKE ARMY MEDICAL CENTER (BAMC)

LifeLink™ Equipment Installation Report

March 19, 2001

Submitted By:

Southwest Research Institute
6220 Culebra Rd.
San Antonio, Texas 78238

In Response To:

Basic Contract Number: V674P-2995
Order Number: 674-W00138

Key Personnel:

Mr. Brian Robey
Southwest Research Institute
Project Manager

Mr. E. Sterling Kinkler, Jr. PE
Southwest Research Institute
Principal Engineer

The views, opinions, and/or findings contained in this report are those of the author's and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

REPORT APPROVAL

Prepared by:

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Principal Engineer
Communications Engineering Department

Approved:

Brian L. Robey
Project Manager
Bioengineering Department

Melvin A. Schrader
Vice President
Automation and Data Systems Division

LIST OF ACRONYMS

ATMS	Advanced Traffic Management System
BAMC	Brooke Army Medical Center
CAT5	Category Five (Copper Network Cable)
CODEC	Video Coder-Decoder or Compresser- Decompresser
dB	Decibel
ED	Emergency Department
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
FC	Type of fiber optic connector
FO	Fiber Optic
GHz	Giga-Hertz
IP	Internet Protocol
ISR	Institute of Surgical Research
LAN	Local Area Network
Mbps	Mega-bits Per Second
MM	Multi Mode (optical fiber)
NMT	Not More Than
OTDR	Optical Time Domain Reflectometer
PS	Power Supply
RJ-45	Type of modular electrical connector used in networks
Rx	Receiver
SAFD	San Antonio Fire Department
SC	Type of fiber optic connector
SM	Single Mode (optical fiber)
SNMP	Simple Network Management Protocol
SwRI	Southwest Research Institute
TOC	Traffic Operations Center
TWT	Time Warner Telecom Company
Tx	Transmitter
TxDOT	Texas Department of Transportation
UPS	Uninterruptible Power Supply
VHS	Very High Speed (video tape recording system)

Table 1. Installed Component Identification

DESCRIPTION	MFG	PART #	SERIAL #
BAMC LIFELINK TERMINAL			
Computer	HP	BrioBA410	US04007295
Keyboard	HP	C4759-60101	C0005120782
Mouse	HP	C4736-60101	LZE02907075
Flat LCD display	HP	D5016A	TWO02912132H
Display power adapter	HP	25-10050.061	2K2801378
Windows NT 4.0 OS	Microsoft	29700-OEM-001724-24066	
CODEC	Viewcast	0142EU	N/A
Sound card	Guillemot	4766017	N/A
Network interface card	3COM	3C905C-TX	N/A
UPS	APC	BK650MC	PB0031222084
Speakers	Labtech	LCS-1070	N/A
Headset	Beyer	DT-108	N/A
Camera (with remote control)	SONY	EVI-G20	100724
CAT5 crossed jumper, 3 meter	NETFORCE	N/A	N/A
BAMC Comm Switchroom			
Chassis shelf	BUD	SA-1755BT	N/A
UPS shelf	BUD	SA-1755BT	N/A
Chassis shelf	NBASE	NC316BU-16/AC	120500AT2865
SNMP module	NBASE	EM316NM	111300AT40147
Redundnat PS	NBASE	NC316-16RPS/AC	121800AT1648
6 port switch	NBASE	EM316-6SW/M	072700AT40054
SM adapter	NBASE	EM316F/S2	110900IS13701
FC/SC SMFO jumpers, 2 meter	Data Optic Cable	N/A	N/A
UPS	APC	BK650MC	PB0039221778
CAT5 jumper, 1 meter	NETFORCE	N/A	N/A
CAT5 crossed jumper, 1 meter	NETFORCE	N/A	N/A
BAMC ED Comm closet			
Chassis	NBASE	NC316BU-4/AC	121200AT3073
4 port switch	NBASE	EM316-4SW	122600AT10049
SNMP module	NBASE	EM316NM	111300AT40617
Redundant PS	NBASE	NC316-4RPS/AC	102500AT1568
MMFO/RJ-45 converter	NBASE	EM316F/M	110900IS16127
CAT5 jumper, 1 meter	NETFORCE	N/A	N/A
CAT5 crossed jumper, 1 meter	NETFORCE	N/A	N/A
CAT5 jumper, 3 meter	NETFORCE	N/A	N/A
SPARE MODULES			
SM adapter	NBASE	EM316F/S2	121000IS17638
SNMP module	NBASE	EM316NM	120200AT40539

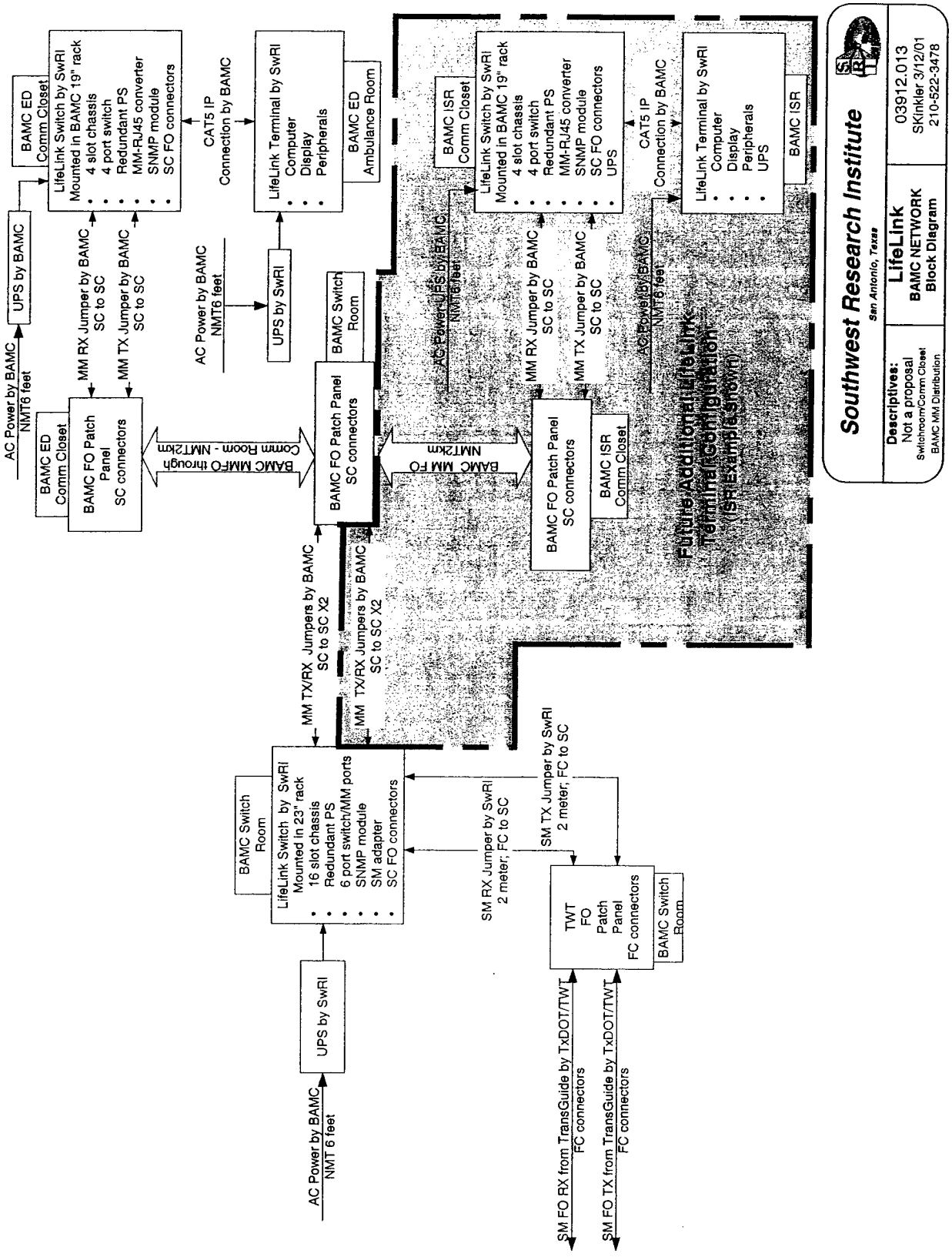

Figure 1. BAMC LifeLink™ System Network Diagram

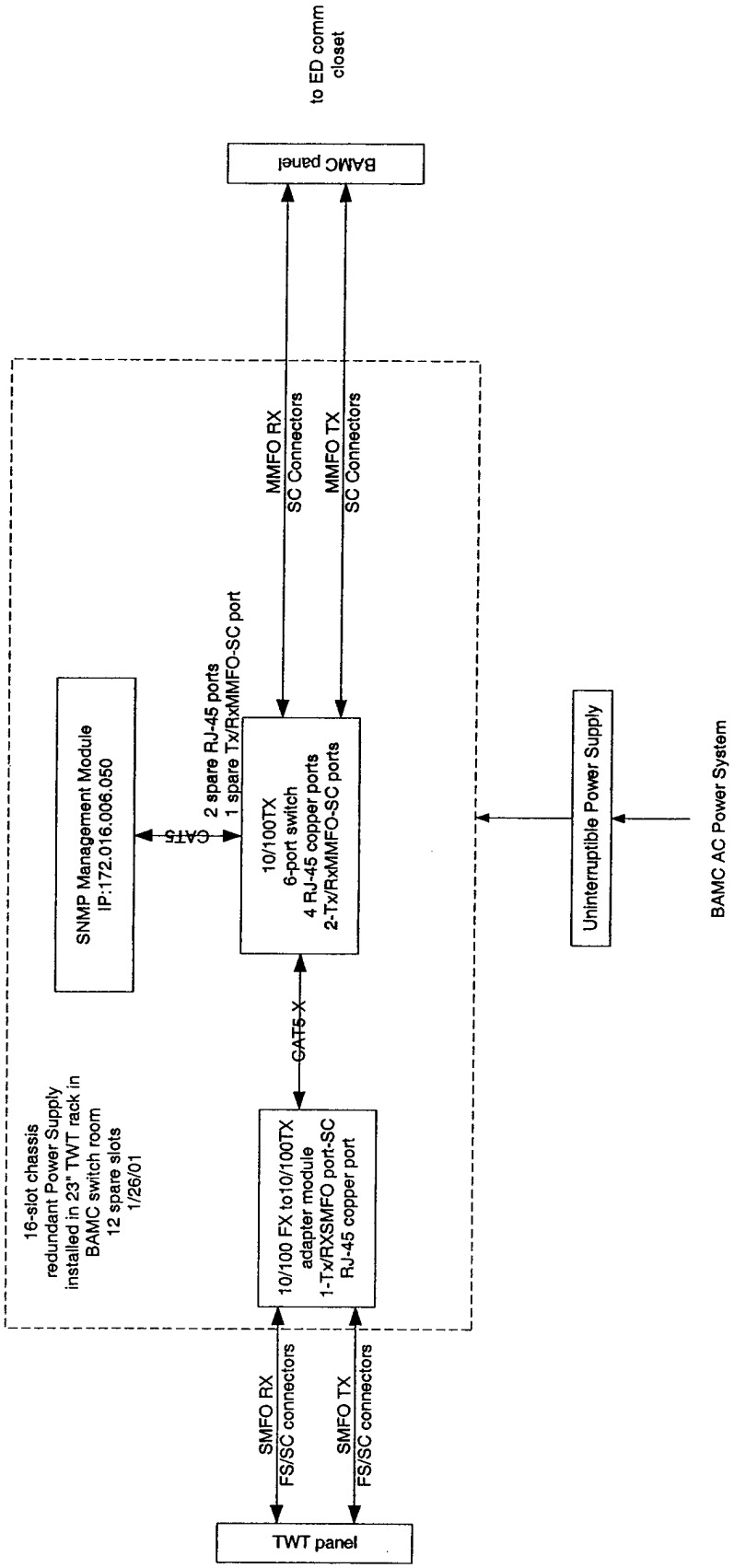

Figure 2. BAMC Communications Switchroom LifeLink™ Equipment Configuration (Room L62-5)

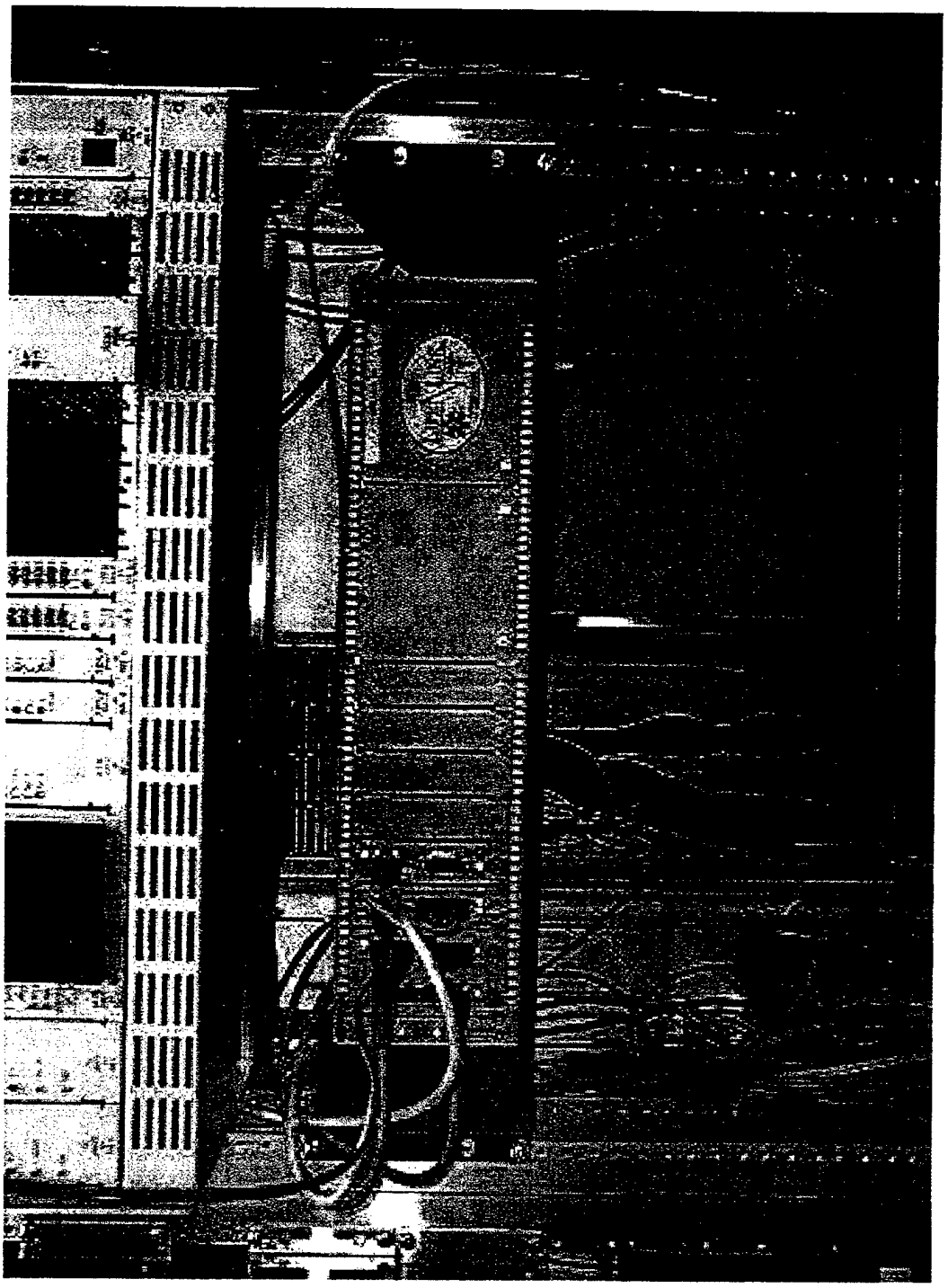

Figure 3. Photograph of LifeLink™ Chassis in BAMC Communications Switchroom (Room L62-5)

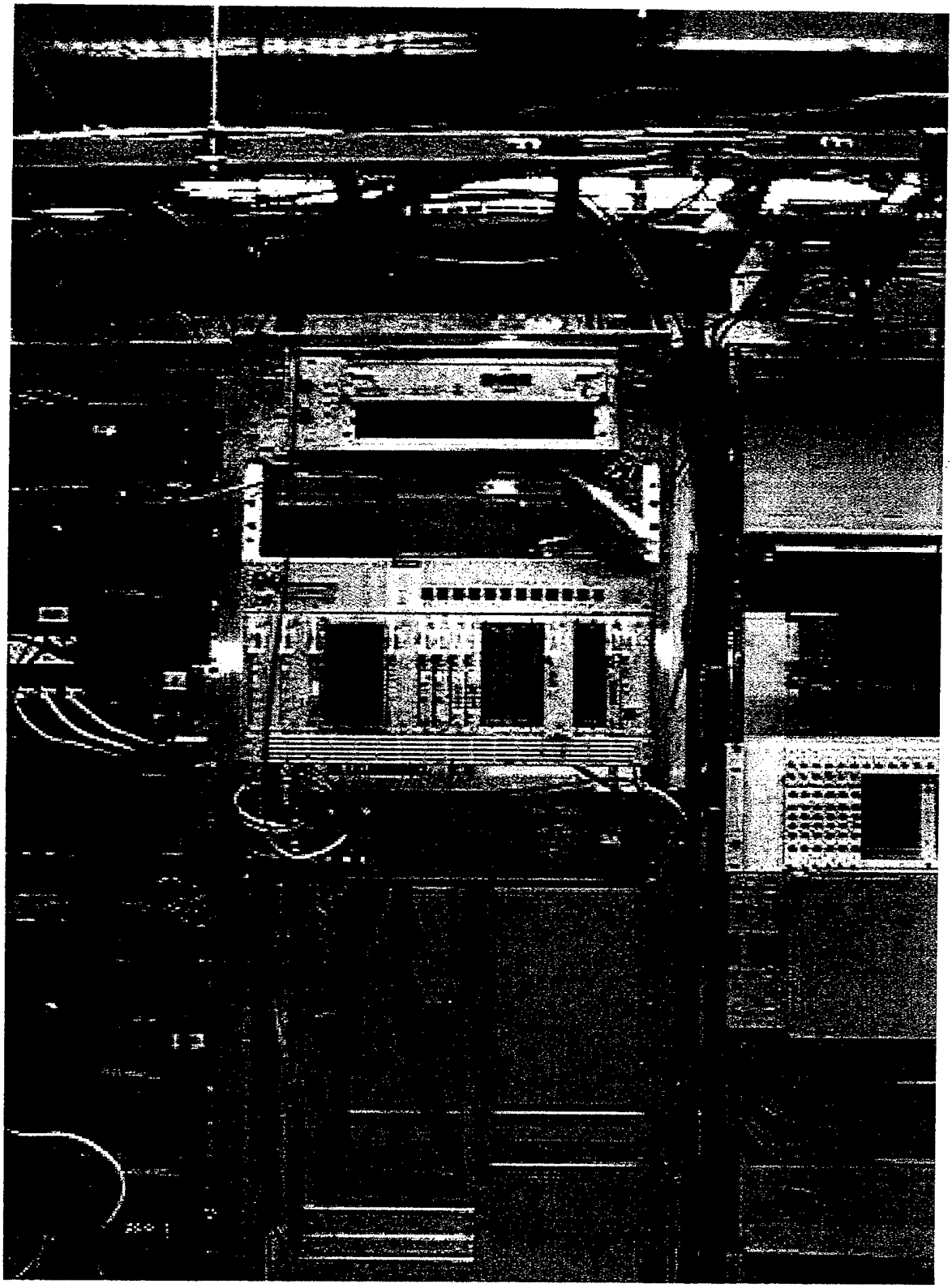

Figure 4. Photograph of LifeLink™ Equipment Showing Relative Location within BAMC Switchroom (Room L62-5)

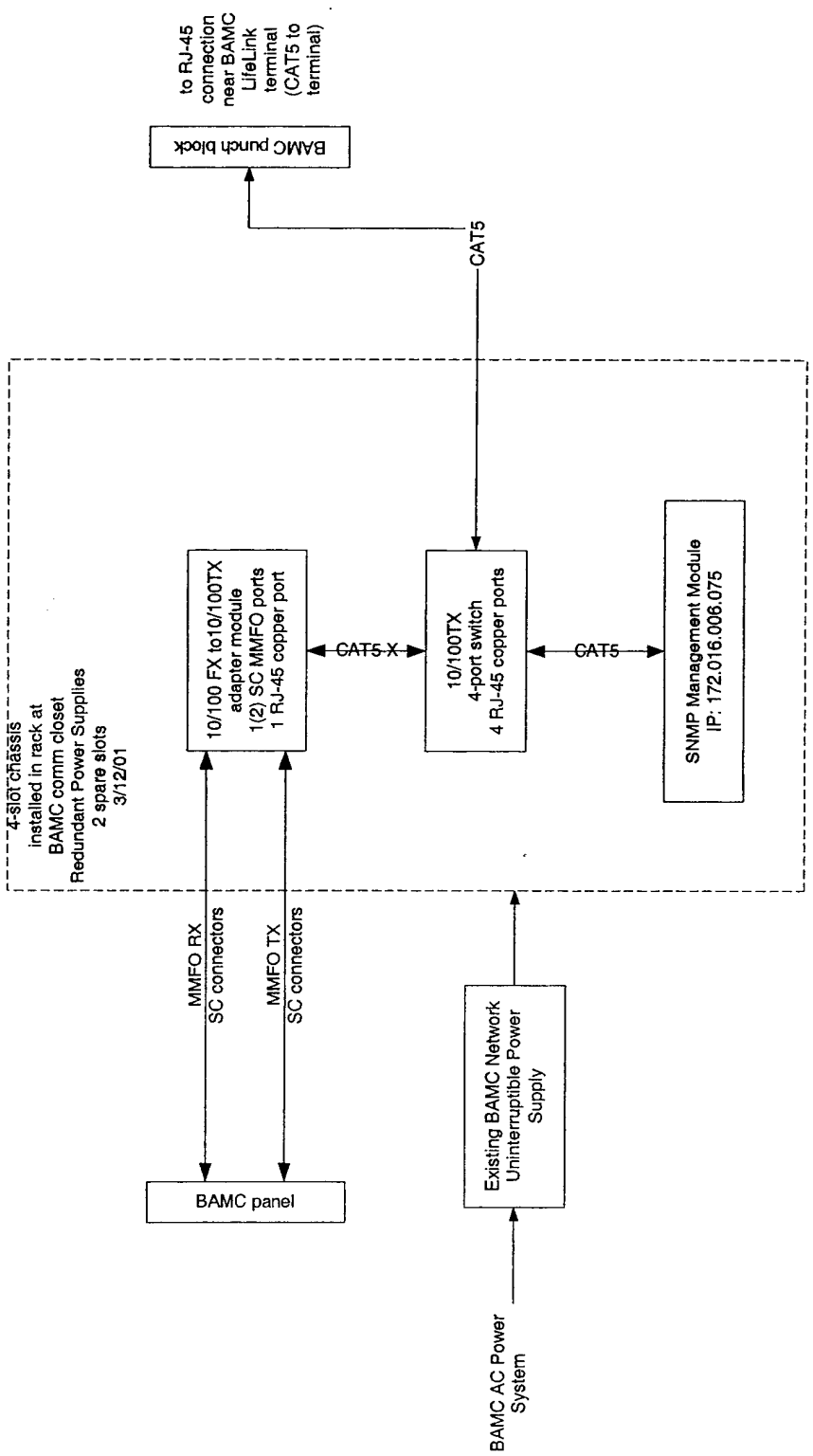

Figure 5. LifeLink™ Equipment Configurations in BAMC Emergency Department Communications Closet (Room120-12)

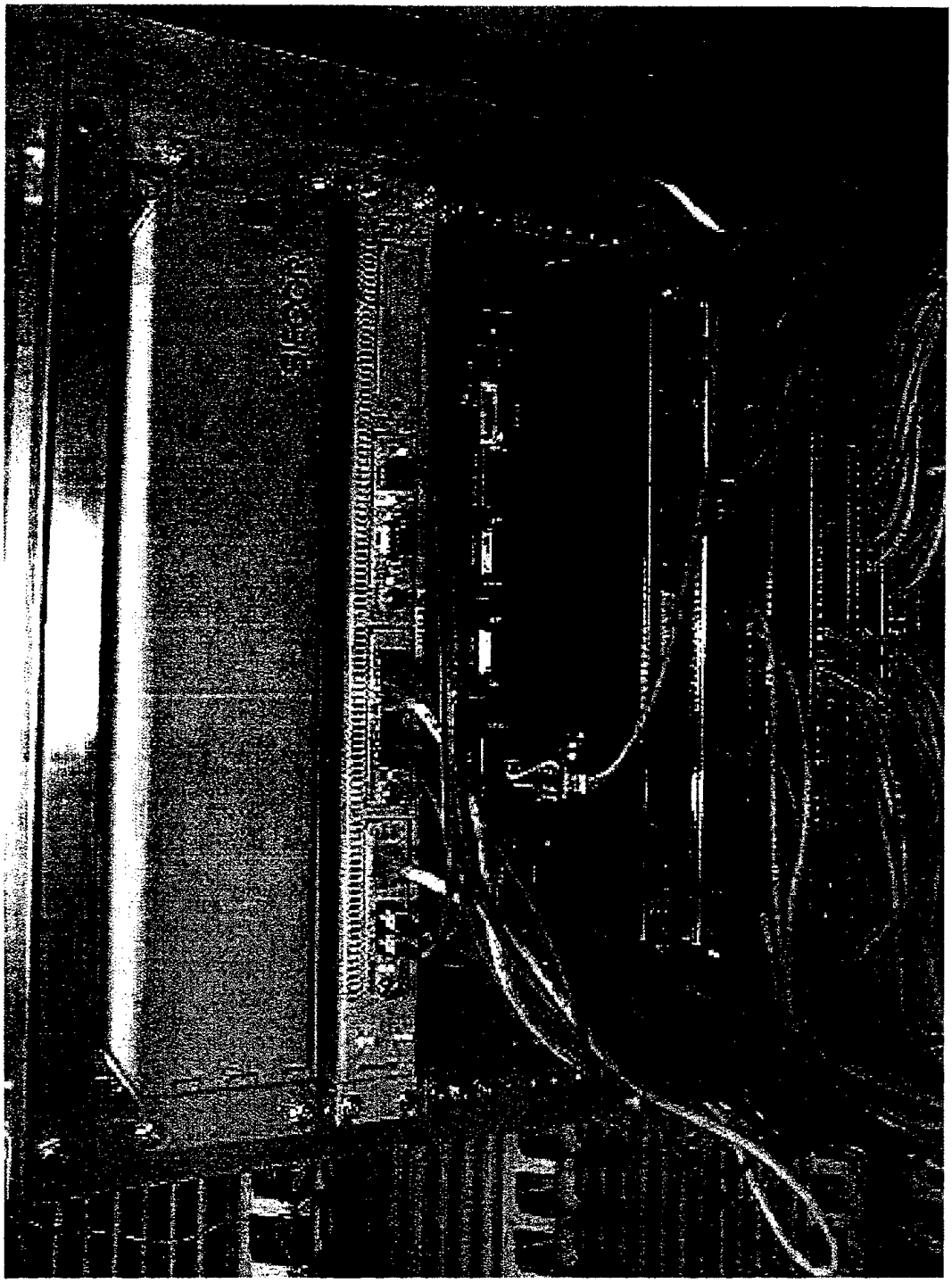

Figure 6. Photograph of LifeLink™ Chassis in BAMC Emergency Department Communications Closet (Room 120-12)

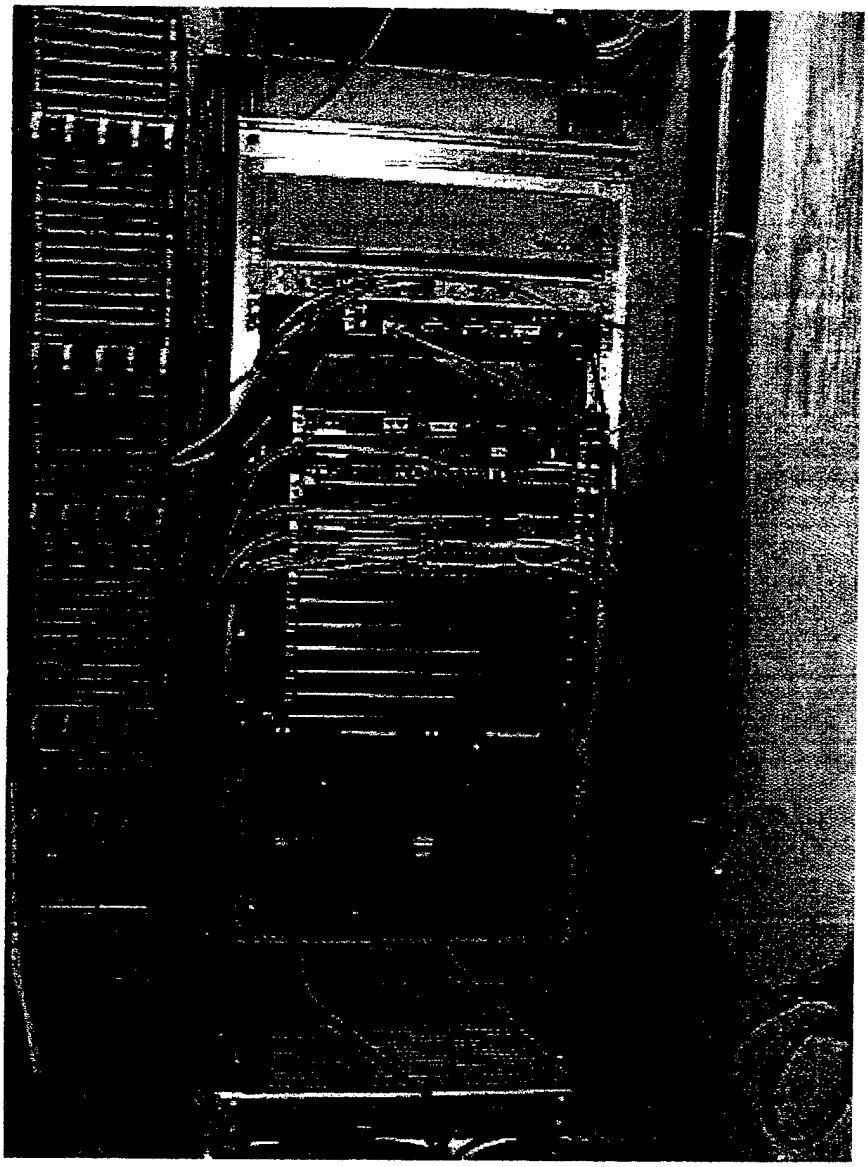

Figure 7. Photograph of LifeLink™ Equipment Showing Relative Location within BAMC Emergency Department Communications Closet (Room 120-12)

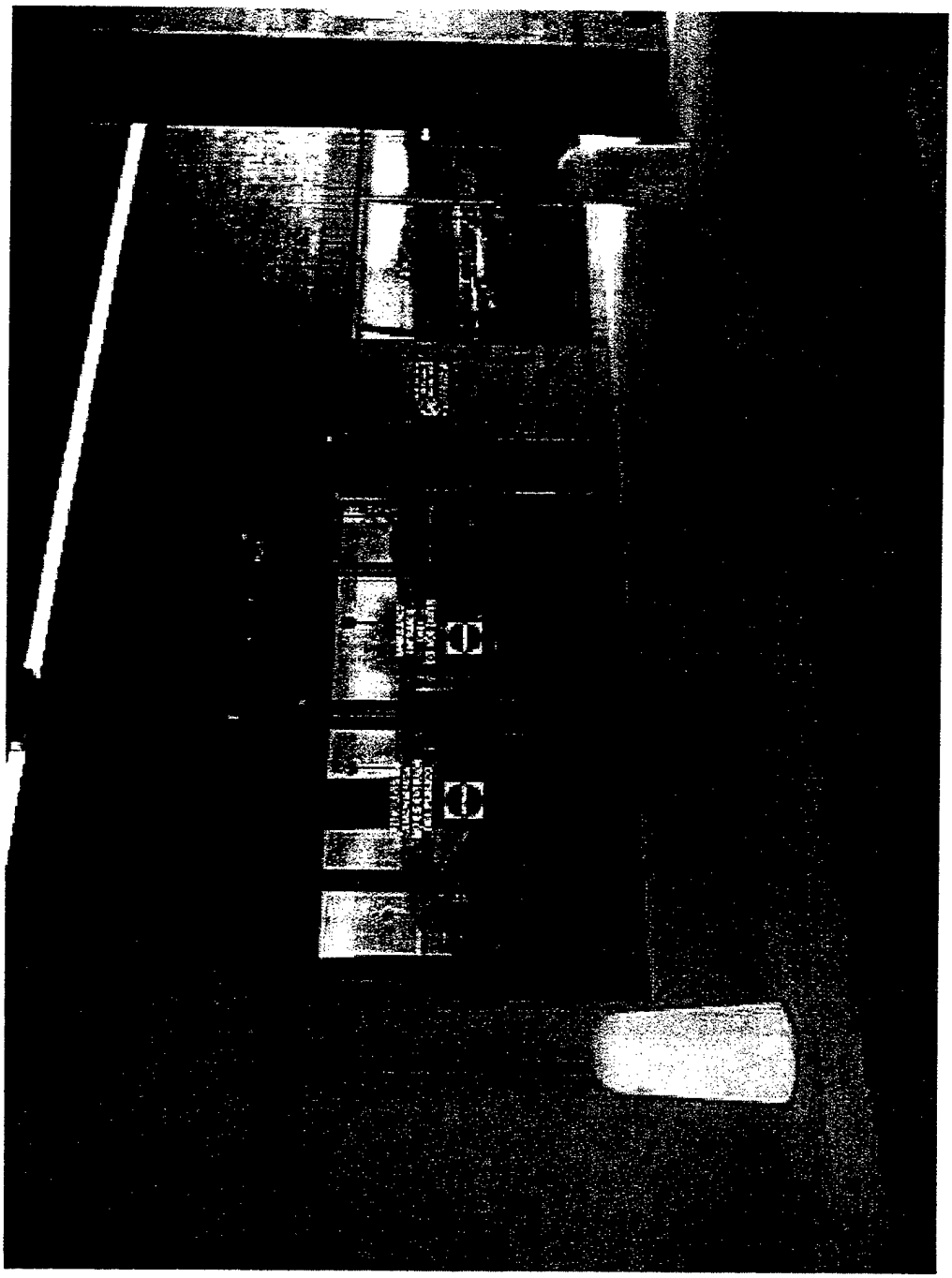

Figure 8. Photograph of BAMC Emergency Department Ambulance Loading Area Showing Relative Location of LifeLink™ Hospital Terminal in EMT Room with Window at Right of Doors

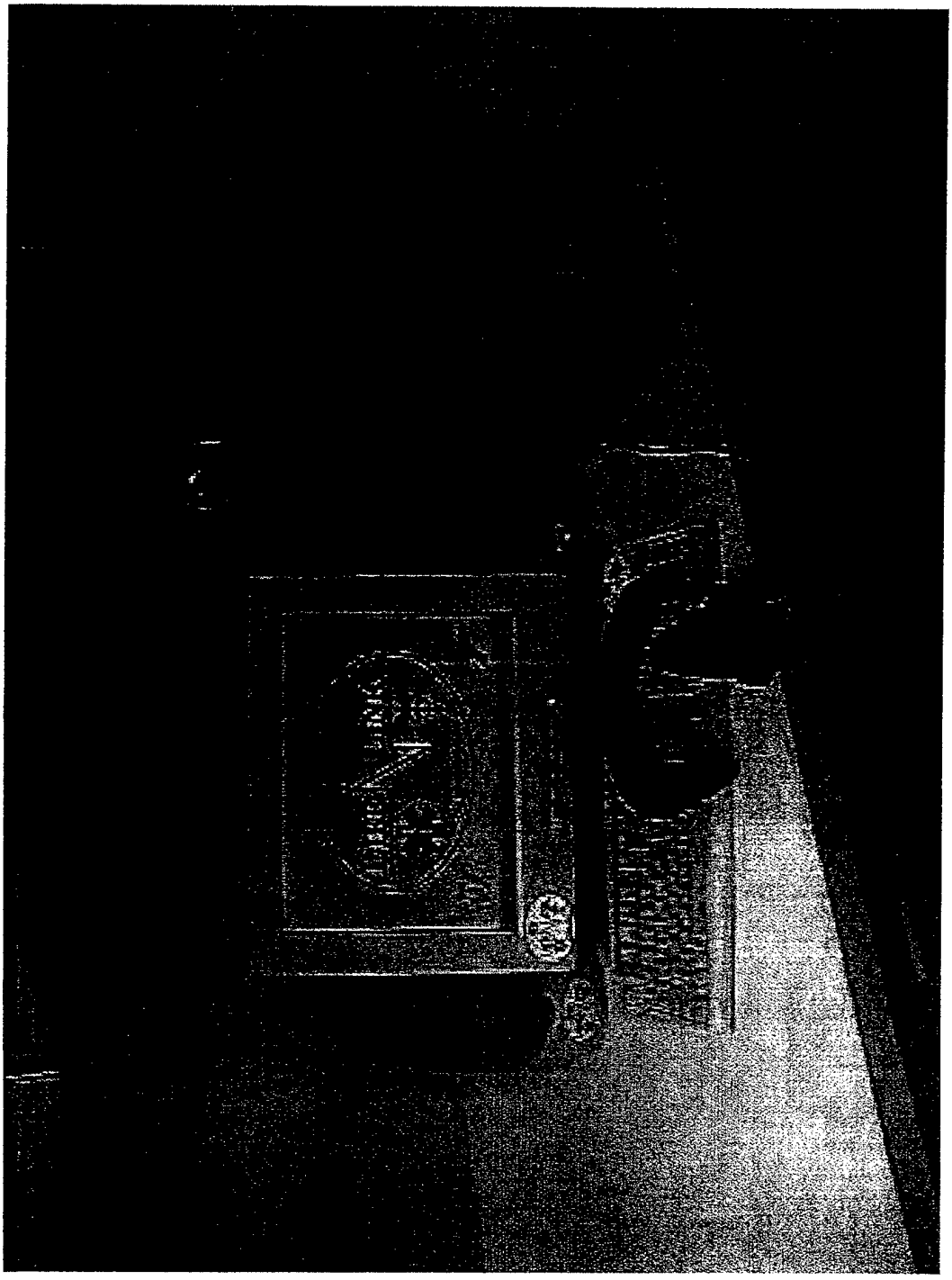

Figure 9. Photograph Of LifeLink™ Hospital Terminal inside BAMC Emergency Department

APPENDIX F. Nonconformity Reports

Controlled Documents # 3912-0201, 3912-0202, 3912-0203, 3912-0204, 3912-0205, 3912-0206

NONCONFORMITY REPORT

BIOENGINEERING DEPARTMENT
SOUTHWEST RESEARCH INSTITUTE

Section 1)

Nonconformity Doc. # **3912-0201**

Description of Discrepancy: Slow Operation

The following discrepancy was observed during preparation and setup of the system.

After running the LifeLink system in the laboratory at SwRI for approximately 72 hours in a static and un-defined mode (February 16-19, 2001), the BRIO terminal (to be installed at Brooke Army Medical Center), when prompted to call the mobile transfer unit (MTU), responded very slowly. An "Audio/Video Failure" alarm window was displayed at the MTU. When the connections finally happened, the video at the MTU looked like several vertically compressed frames, was totally blocked (pixelized), and showed static. Rebooting the MTU did not help. Re-initializing the CODEC equipment from within the LifeLink application at the BRIO terminal resolved the problem.

Initiated by (sign): E. Sterling Kinkler Date: 3/14/01

Project Manager (sign): Brian L. Robey Date 3/13/01

Section 2)

Disposition

Date:

■ Use As-Is ❒ Re-grade ❒ Rework/Repair ❒Scrap ❒ Other

Justification/Remarks:

This is the only occurrence of this problem that has been seen and could not be duplicated. The settings on the BRIO terminal were reviewed and determined to be set appropriately. This problem is not expected to occur in actual use.

Approved by (PM, sign): Brian L. Robey Date: 3/13/01

Approved by (QARA, sign): Robin Santos Date: 3/16/01

Section 3)

Closeout

Reinspected: ❒ Yes ■ No

Method of Reinspection _____ Inspection Report Number: _____

Corrective Action: ❒ Yes ■ No Corrective Action Number: _____

Approved by (PM, sign): Brian L. Robey Date: 3/13/01

Approved by (QARA, sign): Robin Santos Date: 3/16/01

NONCONFORMITY REPORT

BIOENGINEERING DEPARTMENT
SOUTHWEST RESEARCH INSTITUTE

Section 1)
Nonconformity

Doc. # **3912-0202**

Description of Discrepancy: Audio Not Clear

The following discrepancy was observed during preparation and setup of the system on 2/26/01.

After installing the Brio computer at Brooke Army Medical Center (BAMC) and allowing it to run for approximately 72 hours (February 23-26, 2001), there was loud audio static at the SNMP (Texas Department of Transportation) terminal upon establishing a conference. The audio from the BAMC Brio terminal to the SNMP terminal was unusable. Audio from the SNMP to the BAMC terminal was acceptable. Re-booting the SNMP computer did not resolve the discrepancy. Re-initializing the CODEC from within the LifeLink application at the BAMC Brio also did not resolve the discrepancy. Terminating the LifeLink application at the BAMC Brio and re-starting it from the desktop fixed the problem. This problem can be repeated. However, the same fix (i.e., terminating the LifeLink application and restarting the Brio computer) corrects the problem.

Initiated by (sign): E. Sterling Kinkler Date: 3/14/01
Project Manager (sign): Brian L. Robey Date 3/13/01

Section 2)
Disposition

Date:

■ Use As-Is ❒ Re-grade ❒ Rework/Repair ❒Scrap ❒ Other

Justification/Remarks:
When this problem occurs, the temporary fix will be to terminate and re-start the LifeLink application. Users will be advised of this problem during training.

This problem has been documented and is planned to be addressed in future LifeLink application upgrades.

Approved by (PM, sign): Brian L. Robey Date: 3/13/01
Approved by (QARA, sign): Robin Santos Date: 3/16/01

Section 3)
Closeout

Reinspected: ❒ Yes ■ No
Method of Reinspection _____ Inspection Report Number: _____

Corrective Action: ❒ Yes ■ No Corrective Action Number: _____

Approved by (PM, sign): Brian L. Robey Date: 3/13/01
Approved by (QARA, sign): Robin Santos Date: 3/16/01

NONCONFORMITY REPORT

BIOENGINEERING DEPARTMENT
SOUTHWEST RESEARCH INSTITUTE

Section 1)
Nonconformity Doc. # **3912-0203**

Description of Discrepancy: Ambulance Terminal Application Error During Use

The following discrepancy was observed during installation of the system on 02/26/01.

With ambulance traveling the freeways and after an extended out-of-range period and when using the Propaq monitor and sending vitals, the ambulance terminal experienced an "Application Error". Re-booting the ambulance computer returned the system to normal operation. This is the only combination of events and configurations in which this problem has been observed.

Initiated by (sign): E. Sterling Kinkler E. Sterling Kinkler Date: 3/14/01
Project Manager (sign): Brian L. Robey Brian L. Robey Date 3/13/01

Section 2)
Disposition

Date:

■ Use As-Is ❒ Re-grade ❒ Rework/Repair ❒Scrap ❒ Other

Justification/Remarks:

No training or further action is required at this time. This problem has been documented and is planned to be addressed in future LifeLink application upgrades.

Approved by (PM, sign): Brian L. Robey Brian L. Robey Date: 3/13/01
Approved by (QARA, sign): Robin Santos Robin Santos Date: 3/16/01

Section 3)
Closeout

Reinspected: ❒ Yes ■ No

Method of Reinspection _____ Inspection Report Number: _____

Corrective Action: ❒ Yes ■ No Corrective Action Number: _____

Approved by (PM, sign): Brian L. Robey Brian L. Robey Date: 3/13/01
Approved by (QARA, sign): Robin Santos Robin Santos Date: 3/16/01

NONCONFORMITY REPORT

BIOENGINEERING DEPARTMENT
SOUTHWEST RESEARCH INSTITUTE

Section 1)
Nonconformity Doc. # **3912-0204**

Description of Discrepancy: TransGuide Node Freeze and Incorrect Calling Station ID

The following discrepancy was observed during acceptance testing of the system.

On 2/28/01, when the TxDOT node (SNMP) was called by the Brooke Army Medical Center (BAMC) node (F7 mode), the indication at the BAMC node indicated "AMBULANCE SNMP' is connected, rather than "SNMP". Also, the SNMP node froze when the F7 mode was incorrectly used to call itself. This is likely because the software Destination List entry for the SNMP node is inconsistent with the computer name (SNMP).

It should be noted that the SNMP node is not part of LifeLink user operation.

Initiated by (sign): E. Sterling Kinkler E Sterling Kinkler Date: 3/14/01
Project Manager (sign): Brian L. Robey Brian L. Robey Date 3/13/01

Section 2)
Disposition
Date:
☐ Use As-Is ☐ Re-grade ■ Rework/Repair ☐ Scrap ☐ Other
Justification/Remarks:

The Destination List on the SNMP node will be modified to correct this discrepancy.

Approved by (PM, sign): Brian L. Robey Brian L. Robey Date: 3/13/01
Approved by (QARA, sign): Robin Santos Robin Santos Date: 3/16/01

Section 3)
Closeout see memo dated 3/15/2001
Reinspected: ■ Yes ☐ No
Method of Reinspection _____ Inspection Report Number: _____

Corrective Action: ☐ Yes ■ No Corrective Action Number: _____

Approved by (PM, sign): Brian L. Robey Brian L. Robey Date: 3/13/01
Approved by (QARA, sign): Robin Santos Robin Santos Date: 3/16/01

MEMORANDUM

TO: Brian Robey

FROM: Sterling Kinkler 3/15/01

DATE: March 15, 2001

SUBJECT: Rework/repair, reinspection and test re: document #3912-0204

The Destination List at the TxDOT TOC was updated on 3/9/01 as described in the referenced document. The F7 mode (terminal calls itself) issue was tested at the TOC terminal and found to be corrected as planned. On 3/14/01, the related incorrect remote terminal indication issue was tested by calling the TOC terminal from the BAMC terminal. The BAMC terminal indicated the correct identification for the remote (TOC) terminal, again as planned. These actions constitute correction and test of the nonconformity.

NONCONFORMITY REPORT

BIOENGINEERING DEPARTMENT
SOUTHWEST RESEARCH INSTITUTE

Section 1)
Nonconformity Doc. # **3912-0205**

Description of Discrepancy: SNMP Node Freeze After Consulting Termination

The following discrepancy was observed during acceptance testing of the system.

On 2/28/01, when the Brooke Army Medical Center (BAMC) node was conferencing with an ambulance, a consulting call was with the SNMP node. The BAMC/ambulance/SNMP conference was terminated at BAMC and the SNMP was immediately re-called (using the F7 key) from BAMC. The conference disconnect did not complete and the SNMP node froze. Pressing the F1 key (Terminate Conference) at the SNMP node was required to complete the disconnect and return the node to normal operation. Observation was that the new call came into the SNMP node before the consulting call had been terminated.

Initiated by (sign): E. Sterling Kinkler Date: 3/14/01
Project Manager (sign): Brian L. Robey Date 3/13/01

Section 2)
Disposition
Date:

■ Use As-Is ❒ Re-grade ❒ Rework/Repair ❒Scrap ❒ Other

Justification/Remarks:

Users will be trained to press "F1" key to recover operation if this happens during use.
This problem has been documented and is planned to be addressed in future LifeLink application upgrades.

Approved by (PM, sign): Brian L. Robey Date: 3/13/01
Approved by (QARA, sign): Robin Santos Date: 3/16/01

Section 3)
Closeout
Reinspected: ❒ Yes ■ No
Method of Reinspection _____ Inspection Report Number: _____

Corrective Action: ❒ Yes ■ No Corrective Action Number: _____

Approved by (PM, sign): Brian L. Robey Date: 3/13/01
Approved by (QARA, sign): Robin Santos Date: 3/16/01

NONCONFORMITY REPORT

BIOENGINEERING DEPARTMENT
SOUTHWEST RESEARCH INSTITUTE

Section 1)

Nonconformity Doc. # **3912-0206**

Description of Discrepancy: Vitals Failure Window Appears in the Ambulance

The following discrepancy was observed during acceptance testing of the system.

On 2/28/01, during a conference between the ambulance and the Brooke Army Medical Center (BAMC) Brio terminal – the ambulance node experienced a spontaneous "Vitals Error" alarm window. We had been testing vitals transfer earlier in the day, but not during that session. The serial cable that connects the Propaq to the LifeLink distribution box was connected to the distribution box but not to the Propac. The Propac was not on. Two-way voice radios were being used within the ambulance cabin and the alarm may have been associated with the radio use. The alarm was cleared by pressing the "enter button" on the ambulance computer, as prompted by text within the alarm window on the display. This was the only occurrence of this problem seen during installation and testing of the system.

Initiated by (sign): E. Sterling Kinkler E. Sterling Kinkler Date: 3/14/01

Project Manager (sign): Brian L. Robey Brian L. Robey Date 3/13/01

Section 2)

Disposition

Date:

■ Use As-Is ❒ Re-grade ❒ Rework/Repair ❒Scrap ❒ Other

Justification/Remarks:

No training or further action is required at this time.

This problem has been documented and is planned to be addressed in future LifeLink application upgrades.

Approved by (PM, sign): Brian L. Robey Brian L. Robey Date: 3/13/01

Approved by (QARA, sign): Robin Santos Robin Santos Date: 3/16/01

Section 3)

Closeout

Reinspected: ❒ Yes ■ No

Method of Reinspection _____ Inspection Report Number: _____

Corrective Action: ❒ Yes ■ No Corrective Action Number: _____

Approved by (PM, sign): Brian L. Robey Brian L. Robey Date: 3/13/01

Approved by (QARA, sign): Robin Santos Robin Santos Date: 3/16/01

AD NUMBER	DATE 5/10/01	DTIC ACCESSION NOTICE
1. REPORT IDENTIFYING INFORMATION		REQUE
A. ORIGINATING AGENCY USAMRMC		1. Put on r
B. REPORT TITLE AND/PR NUMBER Final (March 2001)		2. Con
C. MONITOR REPORT NUMBER Cox		3. Atta mail
D. PREPARED UNDER CONTRACT NUMBER MIPR 0KC7KAM0021		4. Use infor
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